PACKAGE OF PRACTICES FOR VEGETABLE CROPS

2016

Directorate of Extension
Sher-e-Kashmir
University of Agricultural Sciences & Technology of Jammu

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Foreword

*V*egetables are rightly called “vital, nutritious, healthy foods” as they are rich in minerals, vitamins, carbohydrates and proteins. The per capita consumption of vegetables in our country is very low against WHO standards (180g/day/capita against 300g/day/capita recommended by FAO). Anemia caused by iron deficiency is quite wide spread in the country, the prevalence varying from 45% in adult males to 70% or more in women and children. Thus, there is urgent need for providing health security to our population by supplying nutrition through the balanced diet in the form of vegetables.

In the global endeavour for food and nutritional security, the diversity in vegetable crops and their nutritional value have attained special significance in agriculture. The growth in vegetable sector has played an important role in the country’s economic development, health food and nutritional security. India is second largest producer of vegetable after China and contributes 14% share in world’s total vegetable production. Presently, vegetables occupy an area of 9.20 million hectare with annual production of 162.19 million tonnes and average productivity of 17.6 MT/ha. It is expected that the demand for vegetables may increase to 225 million tonnes by 2020 and 350 million tonnes by 2030. So, India has to go a long way to accelerate vegetable production to keep pace with the growing population. The vegetable production system is one of the important sectors which has shown exponential growth and contributed about 27% share in the state GDP.

In Jammu & Kashmir vegetables are grown over an area of 63.1 thousand ha with annual production of 1395.5 thousand MT and average productivity of 22.1 MT/ha, which is higher than national average of 17.6 MT/ha. This sector assumed economic significance in the state where holding size of farming families is very small (0.66 ha) and majority of the farmers fall in small and marginal group. The vegetable growers of the region have responded very well to the introduction of hybrids /high yielding open pollinated varieties, improved production practices including use of environmental friendly bio-fertilizers, bio-pesticides and organic manures etc. With the development of innovative technologies protected and trench cultivation of vegetables on the perennial river beds are becoming popular amongst the progressive growers for production of early vegetables for higher returns per unit area.

Jammu region of the state is bestowed with agro-climates ranging from subtropical plains with an altitude of 300 m above msl to intermediate lower and higher zones having altitude up to 1500 m above msl and more. There are various niche areas for growing specialty vegetables; for example Marh and Satwari blocks of Jammu district for cole crops, tuber crops, leafy vegetables, okra and cucurbits; Vijaypur block of Samba district for carrot, direct - sown cabbage, cauliflower and turmeric; Tamatar morh (Kud), Chenani and Basht areas of Udhampur district for tomato, capsicum, brinjal and hill cucurbits; Poonch district for garlic and root vegetables; Bhaderwah of Doda district for beans and knol khol; Marwah and Padder areas of Kishtwar district for off-season peas and beans. Besides cultivation of fresh vegetables, there is a great potential for seed production of temperate vegetables including rare exotic vegetables like Broccoli, Lettuce, Kale, Brussel’s sprouts, Chinese cabbage etc.

Off-season vegetable production is another area which has been commercially exploited on large scale under mid-hill conditions of Rajouri, Reasi, Poonch, Doda, Kishtwar, Ramban and parts of Kathua and Udhampur districts. Production and seed production of temperate and exotic

vegetables is the most important area which can elevate the economic status of mid and high zone farmers and can also widen the scope for expanding seed supply in the region.

Development and introduction of high yielding open-pollinated and hybrid varieties tolerant to biotic and abiotic stresses, refinement and development of integrated nutrient management technology for eco-friendly production of major vegetables, standardization and popularization of protected cultivation of high value low volume vegetables, availability of quality planting material, breeder and truthfully labeled seed of high yielding varieties and promotion of under-utilized vegetables are the focus areas to bring the state on national canvas.

Being highly specialized and technical job, vegetable production demands thorough scientific know-how of the each crop on part of the growers. To increase productivity and returns per unit area, an up-to-date ready reckoner of all the vegetables must be available to growers, field functionaries, scientists, and entrepreneurs.

It gives me immense pleasure that Directorate of Extension in collaboration with Division of Vegetable Science and Floriculture has come up with "**Package of Practices for Vegetable crops**" covering latest information on all the aspects of vegetable production on scientific lines including hybrid culture besides day to day information on general awareness. In addition, it also covers important topics like scientific nursery raising, trench cultivation, protected cultivation, viable cropping modules and important guidelines for safe handling of insecticides and pesticides.

I hope this compendium of technologies will serve as an information resource for successful production of summer vegetables for the farmers, students, scientists, extension officers and field functionaries from Departments of Agriculture, Horticulture and Rural Development.

(Pradeep K. Sharma)
VICE CHANCELLOR

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1. Significance and Scope of Vegetable Cultivation

Any part of herbaceous plant which can be used as culinary purpose is known as vegetables. Boswell (1941) described vegetable as all those annuals, biennials and perennials of which mature parts like seeds, roots, fruits and immature parts like stems, leaves, flowers and succulent bulbs are used as culinary purpose.

1.1 Importance of vegetables

Vegetables are one of the cheapest source of natural nutritive foods. Some of the vegetables are good source of carbohydrates (leguminous vegetables, tapioca, sweet potato, yams, colocasia, potato, garlic, onion, brussel's sprouts, methi) proteins (leguminous vegetables like peas and beans, leafy vegetables, garlic, brussels sprouts), vitamin A (tomato, carrot, turnip, leafy vegetables, root vegetables like sweet potato, colocasia and pumpkin-yellow), vitamin B (peas and beans, garlic, colocasia, tomato, asparagus), vitamin C (green chillies, turnip, brussel's sprouts, drum-stick leaves, cauliflower, cabbage, knol-khol, bitter- gourd, radish leaves and leafy vegetables), calcium and iron(all green leafy vegetables, drumstick fruits).

1.2 Nutritive Qualities

Vegetables are the most important natural sources of vitamin A and C, and they rank high as sources of vitamin B1 and B2. Every diet to be called balanced should include at least 300g of vegetables. Besides, vegetables are valued for certain medicinal properties.

1.2.1 Vitamins

Vitamin A is essential for growth and reproduction. It helps in resistance to infections, and increases longevity. It can be obtained from carrot, peas, turnip, beets, tomatoes, sweet potatoes, greens like spinach, methi, green onion, green chillies, cabbage and lettuce etc

Thiamine or Vitamin B1 is essential for the maintenance of good appetite and normal digestion. It is necessary for growth, fertility and lactation and for the normal functioning of nervous tissue. Its deficiency causes disease beri-beri disease. Vegetables like lettuce, cabbage, carrot and onion are rich source of vitamins B1.

Riboflavin or Vitamin B2 is important for respiration in poorly vascularized tissues such as the cornea. It is present in the retinal pigment of the eye where it plays an important part in light adaptation. Deficiency causes pellagra and alopecia. Green contains this vitamin in abundance.

Ascorbic acid or Vitamin C, is a dietary essential for human beings since we cannot synthesize. Deficiency causes scurvy disease, unhealthy gums and delay in wound healing. Green vegetables are an important source of this vitamin these are methi, palak, cabbage, lettuce, green chillies, tomatoes, cauliflower and bitter gourd etc. Vitamin D is essential for the correct utilization of calcium salts and phosphorus in the nutrition of the growing and adult skeletons. It is also necessary for the prevention of rickets, osteomalacia and dental diseases. This is available in green leafy vegetables.

Vitamin E is essential for normal reproduction and is called anti-sterility vitamin. Vegetables like cabbage, lettuce and vegetable oils are the main sources.

Niacin (nicotinic acid) deficiency in human diet causes rough skin, abnormality in the tongue and in cellular respiration. Vegetables like kale, green peas, peppers, potatoes, spinach and tomatoes are the good source of niacin.

Vitamin K is essential for normal blood clotting. Green leafy vegetables are rich sources of this vitamin.

1.2.2 Proteins: These are important for body growth. Proteins contain essential amino acids which are necessary for the formation and maintenance of body tissues. These are found in green vegetables like spinach, green gram, beans and especially in soybean.

1.2.3 Minerals: Vegetables are a rich source of minerals like calcium, phosphorous, and iron etc. Calcium can be obtained from beans, carrot, cabbage, cauliflower, lettuce, onions, spinach, peas, tomatoes, amaranthus, fenugreek etc. Phosphorus from potatoes, carrot, tomatoes, cucumber, spinach, cauliflower, lettuce and Iron from spinach, lettuce, cabbage, peas, beans, tomatoes, carrot, bitter gourd and onion etc.

In short it can be concluded that:

- Vegetables are one of the most important components of balance diet.
- Vegetables increase palatability in foods.
- Vegetables are good source of minerals, vitamins, proteins and carbohydrates
- Vegetables eliminate acidity developed due to non-vegetarian foods.
- Vegetables are valuable roughages having higher digestibility coefficient.
- Vegetables are known to be the cheapest source of natural protective foods.

1.3 Scope of vegetable farming

1.3.1 Most of the vegetables are short duration, fast growing and therefore, more crops can be raised from the same unit of land.

1.3.2 The yield potential of vegetables is very high i.e. about 5 to10 times more than many cereals.

1.3.3 Vegetables fit well in crop rotations, inter-cropping, multiple cropping, mixed and companion cropping systems.

1.3.4 Productivity is high in vegetables so, can be grown on small and marginal holdings.

1.3.5 Kitchen gardening of vegetables have been proved to be the most efficient system of utilizing the home wastes like organic residues and used water.

1.3.6 Vegetables provide vitamins, proteins, carbohydrates, minerals etc when consumed along with some cereals and thus to make a balance diet.

1.3.7 Vegetables can be grown in neglected, places where other crops may not be grown successfully like a backyard, roofs of the houses, corridors, verandahs, windows and several other partial shady places, and can make a substantial contribution in daily requirements besides improving aesthetic values.

1.3.8 Vegetables growing also make more effective use of land and labour resources for agricultural development.

1.3.9 Vegetable growing provides opportunity for employment to rural poor’s as most of the operations are labour intensive and time bound.

1.3.10 Vegetables have vital role to play in national economy and well being of human beings

1.4 Agro-climatic zones of Jammu province

The state of Jammu & Kashmir lies in the North of Indian Union and extends from 32°-17’

to 37°-50’ N Latitude, from 72°-40’ to 8°-30’ E Longitude and forms a transitional region of diverse physical features between the week monsoon zone of Punjab and cold arid dry zone of Tibet. Jammu Division is located between an altitude of ***300 meters*** and 4200 meters above Mean Sea Level (MSL). R.S. Pura in Jammu district and Sumcham (Padder) in Kishtwar district are the lowest and highest permanent settlement points for human population. On the basis of altitude and climate this division has been divided in to three zones. i.e., Sub-tropical, intermediate and temperate zones.

1.4.1 Zone I (Sub-tropical zone)

It spreads between an altitude of 300 meters and 1000 meters above MSL and enshrines Jammu district as a whole and parts of Kathua, Udhampur, Samba and Rajouri districts. This zone is characterized by hot summer, heavy summer monsoon and relatively dry but pronounced winter with pre-ponderance of alluvial soils. Normal summer monsoon ranges between 1200 to 1500 mm from mid June to mid September. It includes irrigated and unirrigated areas of Kathua, Barnoti, Hiranagar, Ghagwal, Samba, Vijaypur, Purmandal, Satwari, Bishnah, R.S. Pura, Marh & Bhalwal, Blocks on the right hand side of Jammu-Pathankot National Highway and Akhnoor, Khour, Nowshera, and Sunderbani Blocks on the Jammu-Poonch Highway.

The major crops of the area are Solanaceous vegetables (Tomato, brinjal, chillies, capsicum and potatoes), Okra, Cole crops (Cabbage, cauliflower and Knolkhol), Root crops (Radish, Carrot and Turnip), Bulb crops (Onion and garlic), Legume crops (Peas and Beans), Cucurbits (Cucumber, pumpkin, bitter gourd, water melon, musk melon, tinda, ash gourd and Ridge gourd),

Leafy vegetables (Spinach, methi, Hak sag and Amaranthus) and Colocasia.

1.4.2 Zone II (Intermediate zone)

This zone is located between an altitude of 1000 meters and 1500 meter above MSL. It consists of some parts of Basholi, Billawar, Ramnagar, Udhampur, Reasi, Pouni, Chenani, Panchari, Ghordi, Mahore, Gool and large area of Kalakot, Budhal, Rajouri, Doda, Darhal, Thathri, Balakot, Ransoo, Assar, Bhagwah, Ramban, Mahore, Mendhar, Poonch, Ghordi, Panchari and Manjakote blocks within the said altitude. Barring some blocks of Doda district i.e. Doda, Bhagwah, Assar and Baggar and some blocks of Udhampur, Ramban and Reasi districts i.e Mahore, Gool & Pouni which are drought prone, this zone has mild summer, fair monsoon during summer and relatively wet winter. The vegetable crops being grown in these areas are cucumber, potato, beans, tomato, garlic, bottle gourd, chillies, capsicum, onion, peas, radish and ginger. The area right from Bhamla, Pauni, Parakh and Katra is famous for growing ginger crop. Likewise farmers of Assar and Baggar area of district Doda, Chenani and Sudh Mahadev belt in district Udhampur grow lot of off-season vegetables and are sent to the plains which fetch very remunerative price to the farmers. Similarly beans and garlic are grown in large area in Rajouri and Poonch districts.

1.4.3 Zone III (Temperate zone)

This zone includes all other areas of Jammu Division which are located above 1500 meters altitude. Of special mention are the blocks of Warwan, Marwah, Dachhan, Chhatru, Paddar, Kishtwar, Thathri, Bhaderwah, Banihal, Mendhar, Manjakot, Bani, Basohli and parts of Bhagwah, Assar, Gool-Gulabgarh, Mahore, Dudu-Basantgarh, Darhal, etc. This zone is characterized by relatively mild but dry summer with little monsoon and fairly cold-wet winter due to the ‘Western Weather Disturbances’. It is mostly a mono-cropped zone with low production & productivity. The hills provide conducive conditions and serve as natural green house for producing of vegetables particularly peas, tomato, beans, cabbage, cauliflower, capsicum, cucumber at such a time when their availability is almost over in plains due to unfavorable agro climatic conditions.

SUMMER

2. Solanaceous Vegetables

2.1 Tomato (*Solanum lycopersicum* L)

Tomato is the most important warm season fruit vegetable grown throughout the world ranking second in importance to potato in many countries. It is widely accepted as 'Protective Food' and is grown extensively in the State. In Jammu region tomato is cultivated over an area of 2500 ha. High consumption of tomatoes and its products has been linked to reduce carcinogenesis, particularly prostate and mouth cancer, and has been thought to be due to the presence of lycopene and carotene, which gives red tomatoes their color.

Climate

Tomato is a warm season plant and cannot withstand severe frosts. It is not only sensitive to frost but it does not thrive at low, non-freezing temperatures. High temperatures, accompanied by low humidity and dry winds, frequently damage floral parts and there is no fruit-set. During hot and drought conditions immature blossoms usually drop because of increased transpiration. The tomato withstands drought fairly well but fruits are subject to blossom end rot and tend to cracks if moisture supply follows drought. Thus both high and low temperatures interfere with the setting of fruit. A warm sunny weather is most suited for its proper ripening, colour, quality and high yields. Fruit set and ripening are temperature dependent and when the temperature exceeds 32°C or goes below 14°C these parameters are adversely affected. The optimum temperature for germination ranges from 18°C to 26°C. Proper colour formation takes place at 26°C-32°C. When temperature exceeds 35°C or goes down to 15.5°C there is a significant inhibition of ripening. It cannot be grown successfully in regions of higher rainfall.

Soil

The tomato grows on all types of soils from light sandy to heavy clay. Soil which is well-drained, fairly light, fertile, organic matter rich with a fair soil water holding capacity is ideal. For early crop, a sandy loam soil is the best. Tomato does well in soil reaction from pH 6.0 to 7.0. It is moderately tolerant to acid soils (pH 5.5).

Varieties

Open pollinated

Pusa Ruby: This is an early maturing variety developed by IAR1, New Delhi; derived through selection from the cross Sioux x Improved Meeruthi. Plants are indeterminate (80-85 cm), spreading and hardy with fewer branches. Fruits are flattish round, small-medium, uniform red, slightly lobed (4-5 locules) and acidic; suitable for processing; suitable for cultivation during autumn, winter and spring-summer seasons; gives an average yield of 30 t/ha.

Pusa-120: Plants are semi determinate, spreading, late maturing with dark green foliage. Fruits are flattish round, attractive, medium to large, uniform red, less acidic, less seeded, resistant to nematode and suitable for winter and summer seasons. Average yield is 300-320 q/ha.

Pusa Sheetal: Plants are determinate, fruit set successfully under low night temperature (up to 8°C) and suitable for early spring season, fruits are flattish round with yellow stem end, smooth, attractive, medium sized, red colour and uniform ripening. Harvesting starts from early March. Average yield is 350 q/ha.

Arka Vikas: Fruits are medium large (80-90g), oblate with light green shoulder, which develop deep red color on ripening. Suitable for fresh market. Adapted to both rain fed and irrigated conditions. Average yield is 350 q/ha.

Arka Abha: Fruits are oblate with light green shoulder. Develops deep red colour on ripening. Average fruit weight is 75g. Resistant to bacterial wilt caused by *Ralstonia solanacearum.* Suitable for fresh market. Average yield is 430 q/ha.

Arka Saurabh: Fruits are medium large (70-80 g), round with light green shoulder, deep red in colour, firm with nipple tip, Suitable for both fresh market and processing. Average yield is 300-350q/ha.

Arka Alok: Fruits are square round on lower cluster, large in size, firm with green shoulder, resistant to bacterial wilt. Suitable for fresh market. Average yield is 460 q/ha.

Kashi Vishesh (DVRT-2): Plants are determinate, dark green, fruits are red, spherical, medium to large sized. First harvest at 70-75 days after transplanting, resistant to TLCV. Average yield is 400-450 q/ha.

Kashi Sharad: Plants are indeterminate, leaves are broad, fruits are attractive red, slightly oval, firm with thick pericarp, longer shelf life, avg. fruit weight is 90-95 g. Average yield is 400-500q/ha.

HS-101: Plants are determinate, multi branched, fruits develop in clusters of 2-3, round, small to medium sized, red at ripening and suitable for winter season cultivation. Average yield is 250-275 q/ha.

Pant Bahar: The plants are bushy and profusely branched. Fruits are flattish round, medium in size with 5-6 locules, slightly ridged and uniform red at maturity. First picking starts in 75-80 days after transplanting. Average yield is 250 q/ha.

Pant T-3: The fruit weight is about 70 g. Fruits become uniform red at maturity. Suitable for processing. Average yield is 300 q/ha.

Pusa Early Dwarf: It is an early ripening selection from the cross between 'Improved Meeruti' and 'Red Cloud'-a typical dwarf type with medium large fruits of uniform colour. It has been observed to do well in both the seasons, and yields 395 q/ha.

Hisar Arun (Sel-7): It is an early maturing variety developed by CCSHAU, Hisar; derived through modified pedigree method from the cross Pusa Early Dwarf x K-l. Plants are determinate dwarf, erect, with cut leave and synchronized clustered flowers, bear 15-20 fruits. Fruits are round, red, medium size (65-70 g), 4-6 locules with deep red flesh. First picking starts in 60-65 days after transplanting; gives an average of 150q/ha and 287 q/ha early and total yield respectively in 80-85 days of crop duration.

Hisar Lalit: It is a nematode resistant variety developed by CCSHAU, Hisar. It is derived from the cross HS101 x Resistant Bangalore. Plants are determinate and early maturing. Fruits are round and medium to large in size. It is suitable for cultivation in nematode infested areas.

Punjab Chhuhara: The plants are dwarf, bushy, determinate with dense and luxuriant foliage. Its dense foliage protects the fruit from sunburn. The fruits are pear shaped, small to medium sized, firm fleshy, less seedy and uniformly red at maturity. Yield: 350-400 q/ha

Poly house cultivation

Pant Poly House Tomato-1: It is suitable for poly house cultivation. Number of fruits per bunch are 5-6. Average fruit weight is 202 g. Average yield is 1400 q/ha.

Pant Poly House Tomato-2: It is suitable for poly house cultivation. Number of fruits per bunch are 7-8. Average fruit weight is 265 g. Average yield is 1800 q/ha.

Sowing Time

Zone	Nursery Sowing	Transplanting
Sub-Tropical	Mid December	End Jan. to mid Feb.
River bed areas	November- December	Dec. - Jan.
Protected Structures	September	October
Intermediate (Mid)	February- March	March-April
Temperate	March-April	April-May

In the sub-tropical plains where frost occurs during winter, usually two successful crops are taken. Under irrigated conditions the first transplanting is done in January after the frost is over. Under rainfed conditions, the transplanting is done around July when the rain has set in. About 4-5 week old seedlings at 3- 4 leaf stage are ideal for transplanting.

Manures and fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	120 (250.0)	60 (132.0)	60 (102.0)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 30 days interval after transplanting.

Integrated nutrient management

1. Two foliar sprays of 0.5% $ZnSO_4$ is beneficial for yield and quality.
2. Two foliar sprays of 0.2% calcium chloride and two sprays of 0.3% Borax can check blossom end rot and fruit cracking.
3. Calcium ammonium nitrate can be used as the source of nitrogen in calcium deficient soil.
4. Apply vermicompost @ 4-6 t/ha as broadcasting during final land preparation.
5. Apply *Azotobactor* or phosphate solublizing bacteria @ 800g/ha as seedling root dip. Prepare a suspension of bacterial inoculants in sufficient water. Dip the seedlings in bacterial suspension in shade for 2-3 hours and transplant immediately.

Seed Rate: The quantity of seed varies with season and method of cultivation.

Open pollinated: 500g/ha

Spacing: 60 cm x 45 cm

Irrigation

The irrigation should be so arranged that the soil remains moderately moist. Excessive irrigation induces the plant to vine and dropping off the blossoms. During summer season, irrigation at every 3 to 4 days interval is necessary, whereas for winter and spring season crop 10

to 15 days interval is sufficient. Subsequent irrigations are given according to need of the crop. Irrigation at flowering and fruiting stage is imperative for higher quality yields.

Interculture operation

Weeding and hoeing should be done at regular intervals so as to keep the field free of weeds and to facilitate soil aeration and proper root development. The early stage of the crop is the critical period for weed competition and during this period free environment is needed to ensure good growth and yield.

Important weeds: *Trianthema portulacastrum (Itsit), Digeria arvensis (Takla), Amaranthus virdis (Cholai and Portulaca oleracea (Lunar)*

Control measures

1. Two hoeing in the first and third fortnights after transplanting will keep down the weeds.
2. Application of Lasso 2.0 lit/ha plus one hand weeding results in controlling weeds from the initial stage of crop growth and yield.
3. Metribuzin (Sencor) 0.5 kg/ha or alachlor 2.3 kg/ha plus one hand weeding proved most effective.
4. Treflan (Trifluralin) at the rate of 25 kg/ha was effective in controlling the weeds of tomato for about two-and-a-half months.

Plant Growth Regulators

Spray of gibberellic acid (50 ppm) at the fruit-setting stage increased the ascorbic acid content. The application of GA3 at 25 ppm proved most effective for improving the quality and yield of tomato fruits when sprayed on plants at flower initiation stage.

Mulching

Occasionally tomatoes are mulched with straw when the plants are 30-40 cm high. Mulching keeps vines and fruits away from touching the soil and reduces the pre harvest losses of fruits due to fruit rot. It helps to conserve soil moisture and checks growth of weeds besides lessen the incidence of blossom-end-rot and cracking.

Pruning and staking

All the side shoots are removed by pinching so that plant may use all its food and energy to develop its fruits. Tomato plants should be staked 2-3 weeks after transplanting. Staking should be done with any local material. Pruning and training of tomato plants has not become popular in our State except in some F1 hybrids, because of non-consistent results at various places and the cost involved therein.

Maturity index and Harvesting

Depending on the mode of disposal, the tomato fruits may be harvested at various stages of maturity:

- Green stage: The fruits are fully developed but are green and suitable for sending to distant markets.
- Pink stage-Some of the portion is red or pink and the fruit is not fully ripe. It is most suited for local markets.
- Ripe stage: The major portion of the fruit is red and the softening begins. It may be picked up for home or table use.

- Full ripe stage: The fruit develops maximum colour and turns soft. It is suited for processing purposes.

Yield: The fruit yield varies from 250 to 500 quintals per hectare

Grading

After removing green, over ripe, rotten, injured and defective tomato fruits they should be graded into four grades Super A, Super, Fancy and Commercial. Packing is done in bamboo baskets, plastic trays and polythene bags.

Storage

Pre cooling of tomato after harvest at 12°-13°C on the farm prolongs their storage life. Usually the plastic crates and wooden boxes of various size are used for packing and long distance transportation. Mature green fruits may be stored at 10°C to 15°C for 30 days and ripe tomatoes at 4.5°C for 10 days under 85-90 per cent relative humidity.

Seed production

Tomato is a self pollinated crop. Its seed crop should be provided an isolation distance of 50 metres from the other tomato varieties or some variety not conforming to varietal purity. The off type plant in respect of foliage, plant characters, flowering and fruits should be rouged out. True to type plants should be selected for seed production. Tomato crop is harvested for seed when majority of fruits are ripe. Unripe, green, yellow or sun scalded, diseased and rotten fruits should be discarded for seed harvesting.

Tomato Seed Production

Isolation: Maintain isolation distance of 50 m for foundation seed and 25 m for certified seed between two varieties. Though tomato is self pollinated crop but a certain percentage of cross-pollination has been reported

Field inspection and rouging*:* Follow strictly field inspection and rouging for off types and diseased plants at least three times. The details are as follows:

Before flowering*:* Check for off-type foliage, general plant type including determinate and indeterminate habit, vigour etc. check for diseased plants.

Flowering and immature fruiting stage*:* Check fruit size, shape and unripe colour, check diseased plants.

Mature fruit stage: Check fruit size, shape, colour and internal features; check diseased plants

Harvesting: Harvest fully ripe tomatoes and sort out all green, rotten, injured and defective fruits.

Seed Extraction

Fermentation method*:* The ripe fruits are crushed well by hand or by any mechanical method to make slurry in a non-metallic container wooden or earthern pots for two to three days during the month of May-June in Northern plains. Fruit juice should not be allowed to drain out. The entire material is kept as such till it ferments. When fermentation is completed it shows profuse foam formation on the upper surface of material and tomato flesh separated from seeds completely. The material should be stirred every morning and evening to avoid any fungal growth. The liquid is decanted off and seeds are washed at least 8 to 10 times with clean water. Seeds are spread thinly in the sun for drying.

Alkali treatment method

The extracted material with pulp is treated with an alkali mixture (300 g of ordinary washing soda is added to 4 litres of boiling water) in equal volume. When the alkali mixture is cooled, allow it to stand overnight in an eathern pot. Next day, all the seeds will settle down at the bottom of the container. The liquid is decanted off. Seeds are washed thoroughly with clean water and allowed to dry in the sun.

Acid treatment method

Commercial grade hydrochloric acid 15 ml/kg of fruit pulp is sufficient to disintegrate mucilaginous material surrounding the seed. The seeds separate out from the pulp within half an hour. The pulp is then again stirred and washed thoroughly with clean water and seeds are allowed to dry in the sun.

Mechanical method: Tomato seed and pulp can also be separated from juice through juice extraction machine or an Axial-Flow Vegetable Seed Extraction Machine. After repeated washing with water, seed is dried under open or artificial conditions (38°C) so that moisture content does not exceed 8%. Properly stored seed remain viable for 2-3 years.

Seed yield: Average seed yield is about 150 kg/hectare.

Drying and storing

On small scale seed production, the drying of seeds can be done in the sun whereas on large scale it is done in drier. Drying of seeds up to 10-12 per cent moisture can be easily done in the sun. In the drier, it may be done up to 7 or 8 per cent moisture. Storing of seeds is done with 8-10 per cent moisture in container of moisture-vapor proof. Before filling the seeds in container they are treated with Captan or Thiram 75 WDP at 3g/kg seed. Such seeds remain viable up to 70-80 per cent at the end of about 25 to 30 months of storage.

Field standards for tomato seed production (maximum permitted in per cent)

Factors	Foundation seed	Certified Seed
Off-type	0.10	0.50
Other crop plants	-	-
Objectionable weed plants	-	-
Diseased plants	0.10	0.50

Seed standards for tomato seed production (in percentage)

Standard	Foundation Seed	Certified Seed
Pure seed (minimum)	98.0	98.0
Inert matter (maximum)	2.0	2.0
Other crop seed (maximum)	0.05	0.10
Total weed seeds (maximum)	None	None
Objectionable weed seed (maximum)	-	-
Germination (minimum)	70.0	70.0
Moisture (maximum)	8.0	8.0

Non Parasitic/ Physiological disorders in tomato

Blossom-end rot

This is a physiological disorder. Brown discoloration appears at the blossom-end. The spots enlarge and cover up to the considerable area of the fruit. When plants grow under water deficit conditions or when plants become unable to draw sufficient water due to their damaged roots then the cells at the blossom-end of the fruit fail to get adequate quantity of water which results in breakdown of the tissues and ultimately they rot. It is reported that calcium deficiency leads to blossom-end rot.

Control measures

- Provide support to the plants by stakes.
- Maintain soil moisture through light and frequent irrigations.
- Provide good drainage
- Spray calcium chloride (0.5%) at the time of fruit development
- Locate resistant varieties to blossom-end rot.

Fruit cracking

This disorder in tomato is commonly observed during rainy season. Mature green and fully ripe fruits are liable to cracking. Fruits develop crack either radial or concentric type. The following some probable reasons for fruit cracking in tomatoes are:

- Application of water when the soil has been dry for some time.
- Long spell or dry period and low humidity.
- Exposure of fruits to sun due to pruning and staking.
- Varietal character, a few varieties may be bit sensitive such as Mar globe, Bonny Best etc.
- Deficiency of boron.

Control measures

- Harvest the fruits before full ripe stage. It will reduce the incidence of radial cracking.
- Supply sufficient soil moisture throughout growing season of the crop
- Use resistant varieties like Sioux, Punjab Chuhara, Roma and Pusa Ruby
- Avoid staking of tomatoes during summer season.
- Spray borax at 0.3 to 0.4 per cent on tomato seedlings in nursery just before transplanting and repeat the spray 3 to 5 weeks after transplanting and the third spray may be done after the same interval if needed

Flower drop and poor fruit-setting

Flower drop and poor fruit-set in tomato is a common problem. It is due to imbalance supply of nutrition, incorrect method and time of application; abnormal weather conditions in that both the low and high temperatures affect fruit-set adversely and enhance flower drop. It has been reported that night temperature below 13°C and day temperature above 38°C cause flower drop and poor fruit-set in tomato. Hot dry winds and high light intensity are also responsible for poor

fruit-set and drop during summer. The poor fruit setting sometimes causes due to failure of pollination or fertilization that can be overcome by the use of 2, 4-D at 1 to 2 ppm along with urea at 1 per cent in the form of foliar spray at flowering stage.

Inadequate availability of soil moisture during flowering and fruit setting stage results in more flower drop and poor fruit-set. Therefore, moisture supply should be carefully regulated. Generally winter season tomatoes require irrigation at 8.10 days interval whereas that of summer season tomatoes at 4-5 days interval Excess moisture may favour excessive vegetative growth and abscission of most of the early flower.

Sun scalding

This disorder is due to the exposure of fruits to the intense sunlight. Affected fruits show yellow patches on the fruits. Patches enlarge and tissues are damaged and shrink. The surface of affected fruits shows burning effect. Sometimes, such patches may also be invaded by fungi which cause decay.

Control measures

- Avoid wider plant spacing.
- Protect plants from defoliation by diseases, insect-pests, and pruning and staking.
- Follow good management practices for growing healthy crop.
- Select varieties with dense foliage where this disorder is common.
- A void turning over the plants at the time of harvesting of fruits.

Pocket or puffiness

This disorder is common during winter season. The affected fruits are light in weight and feel soft. Sometimes, surface of fruit is flattened and locular cavities are large and partially filled with pulp and seeds. The environmental (temperature and moisture) and nutritional (nitrogen) factors become limiting for proper pollination, fertilization and development of internal tissues of the fruits. High soil moisture and more nitrogen may result in more puffy fruits. This disorder is also said to be varietal character.

Control measures

- Always avoid overwatering of the tomato crop.
- Apply Jess nitrogen during short days and low light intensity than when grown under long days and high light intensity.
- Locate for resistant varieties in the region where this disorder is known to be serious
- Irrigate crop very lightly and increase the interval of irrigation so that high moisture conditions are avoided.

Cat face

The damaged fruits are distinguished by the distortion of the blossom end rot and have ridges, furrows, indentations and blotches.

Control measures

- Grow resistant varieties
- Provide normal growing conditions.

Hail injury

It is natural calamity. The hail hit the fruits results in injury spots with sunken areas. The spots may turn white to yellow green. The underlying tissues become spongy in texture and whitish in colour.

Sun injury

The fruit surface exposed to the sun may become yellow or develop brown burnt areas. This may be reduced by the use of varieties with abundant foliage so as to cover the fruits with leaves. While picking the fruits from the vine, care should be taken not to turn the plants. Foliage diseases may be controlled timely so as to avoid defoliation leading to exposure of fruits to sun.

Hybrid tomato cultivation

Arka Vardan: High yielding F1 hybrid with root knot nematode resistance. Suitable for fresh market. Average yield is 750 q/ha in 160 days.

Pusa Hybrid-2: Plants are compact, semi determinate with good foliage cover. Fruits are round to flattish round, firm, smooth and attractive with uniform red color at maturity. Plants are highly tolerant to root knot nematode. Average yield is 600-625 q/ha.

Rupali: This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilts. Fruits are orange-red, oblong, 90 g of average weight, firm with 5.6% of TSS; gives an average yield of 79.5 t/ha.

NS-815: This is an early maturing and determinate hybrid, developed by Mamdhari Seeds Pvt. Ltd., Bangalore. Fruits are blocky, square-round, medium size (70-80 g), excellent appearance and firmness with uniform green and round shoulder, low pH with good colour and high soluble solid also suitable for processing.

NS-2530: This is an early maturing hybrid, developed by Namdhari Seeds Pvt. Ltd., Bangalore. Plants are determinate and prolific bearer. Fruits are oval medium size (80-90 g), attractive, red with superior firmness.

Pusa Hybrid-2: This determinate hybrid has been developed by IARI, New Delhi. Fruits are round, medium with good keeping quality; field resistance to nematodes; gives an average yield of 55 t/ha.

Avinash-2: This hybrid has been developed by Syngenta India seeds, Pune. Plants are determinate with very vigorous growth, dense foliage and profuse fruit setting. Fruits are medium, thick walled, round, glossy, dark red with average weight of 70-90 g; first picking starts at 55 days after transplanting; gives an average yield of 75 t/ha; suitable for cultivation in TYLCV prone areas.

Naveen: This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilts. Fruits are dark red, oblong, intermediate firmness with 6.2% TSS and 90 g average weight; gives an average yield of 57.5 t/ha.

Rashmi: This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilt and early blight. Fruits are oblong,dark red, 65 g of average weight, intermediate firmness with 5.5% of TSS; gives an average yield of 67.5 t/ha.

Meenakshi: This is indeterminate hybrid, developed by Bejo Sheetal Seeds Pvt. Ltd., Jalna. Fruits are dark red, round-global, 80 g of average weight and very attractive; gives an average yield of 70 t/ha.

Tolstoi: This is indeterminate hybrid developed by Bejo Sheetal Seeds Pvt. Ltd., Jalna. Fruits are dark square-round, average weight 100 g, very attractive and firm. First picking red, starts on 70-75 days after transplanting; gives an average yield of 75.5 t/ha.

Seed rate: 250 g/ha

Spacing: 90 cm x 60 cm

Manures and fertilizers:

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	200 (420.0)	100 (222.0)	100 (170.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at 30 days interval after transplanting.

Yield: 600-800q/ha

2.2 Brinjal / Egg plant (*Solanum melongena*)

Brinjal is the most common, popular and principal vegetable crop grown widely in India for its varied shape, size and colour of fruits. High productivity, wide adaptation and ease in availability make the crop to find its place as poor man's crop. Its fruits are fairly good source of calcium, phosphorus, iron and vitamins particularly - B group. Brinjal has cholesterol reducing properties due to the presence of higher amount of poly-unsaturated fatty acids in pulp and seeds.

Climate

It is a warm season crop and requires a relatively long growing season with plenty of sunshine and moderate day temperature of 21°-27°C. Extreme temperature (below 10°C and above 30°C) adversely affects fruit setting. Warm and humid climate favours luxurious growth and cool climate restricts the growth.

Soil

It can be grown in all types of soils, but well drained fertile, rich in organic matter silt or clay loam soils are ideal. The optimum pH is between 5.5-6.6, although it can tolerate a little soil acidity. Sandy loam soil is best for early crop and clay loam soil for higher yield.

Varieties

Long fruited

Pusa Purple Cluster: Purple pigmentation on stem and leaves, Fruits are 10-12 cm long, borne in clusters of 4-9. This variety possesses field resistance to bacterial wilt. First picking starts in 60-65 days after transplanting. Average yield is 250 q/ha.

Pant Samrat: It is a long fruited variety which produces dark purple medium to long fruits in clusters. Plants are tall (80-100 cm). Young leaves are purplish green. This variety possesses field resistance to bacterial wilt and phomopsis blight. First picking starts in 70 days after transplanting. Average yield is 300 q/ha.

PH-4: Plants are bushy, fruits are medium long and thin, deep purple in colour, flesh is light green. Average yield is 250-300 q/ha.

Round fruited

Pant Rituraj: It is a round fruited variety which produces purple coloured fruits slightly tapering

towards the bottom. Young leaves are purplish green. It is suitable for planting both in winter and summer season. First picking starts in 60 days after transplanting. Average yield is 300 q/ha.

BR-112: Plants are bushy, fruits are round, bright purple in colour and fleshy. Average yield is 250 q/ha.

Hisar Shyamal: Fruits are round, bright and dark purple in colour. Average yield is 300-325 q/ha.

Seed rate: 500 g/ha

Planting time

Zone		Seed sowing	Transplanting
Sub-tropical	Ist Crop	January	February
	IInd Crop	February - March	March - April
	IIIrd Crop	May	June
Intermediate (Low)		March - April	April - May
Intermediate (High)		March - April	April - May

Land preparation

Prepare the land in well advance with repeated ploughings (At least 4-5 ploughings) to a fine tilth. Remove all the stubbles and weeds from the land. Add well rotten FYM or compost @ 20-25t/ha during land preparation and level the land properly.

Spacing

- Round fruited cultivars: 90 x 90 cm
- Long fruited cultivars: 60 x 45 cm

Manures and fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	100 (206.0)	60 (132.0)	30 (51.0)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses after taking two pickings.

Integrated nutrient management

- Two foliar sprays of 0.5% $ZnSO_4$ and single spray of 0.15% $CuSO_4$ increase yield and quality of fruits.
- Apply vermicompost @ 4-6 t/ha as broadcasting during final land preparation.
- Apply *Azotobactor* or Phosphate Solublizing Bacteria @ 800g/ha as seedling root dip. Prepare a suspension of bacterial inoculants in sufficient water. Dip the seedlings in bacterial suspension in shade for 2-3 hours and transplant immediately.

Irrigation

Brinjal being a shallow rooted crop needs irrigation at frequent interval. During summer, apply irrigation at 4-5 days interval and during winter at 10-15 days interval. About 100-110 cm.

total water is needed for successful brinjal crop and in total 14-16 irrigations are needed. Furrow method of irrigation is the most common method.

Weeding and hoeing

Practice shallow inters - cultivation particularly a few days after every irrigation to remove the weeds and to conserve the moisture. 3-4 hoeings are normally needed to check the weeds growth. Earthing up after second top dressing of nitrogen is quite beneficial. Regarding chemical weed control, a pre plant application of pendimethalin (Stomp 30 EC) @1.0 kg a.i./ ha is effective.

Harvesting and storage

Harvest the fruits when they develop good colour, marketable size but still glossy, immature and tender. Generally 15-19 days fruits are optimally matured for harvest. The good marketable quality fruits are bright, glossy appearance having freshness and optimum size without any fading or change in original colour. The fruits are harvested with stalk at joint. Under ordinary conditions, the normal storage life of brinjal fruits is 1-2 days in the winter months. However, 2-3 weeks storage life can be achieved when fruits are stored in cold storage at 8°-10°C temperature and 85-90% relative humidity. For long distance transport, fruits should be harvested towards the evening hours and thereafter cooled them with sprinkling of water. Store the fruits in perforated polythene bags or PVC stretch film.

Brinjal seed production

An isolation distance of 200 m must be maintained between different varieties or from same variety that does not confirm to varietal purity standards. To ensure the production of pure seed, off type plants, early or late in flowering and those not confirming the genetic purity should be rouged out before flowering, at flowering and when fruits are at edible stage. The fruits of the individual plants should be carefully observed for their shape, size, colour and other characters.

Seed extraction

Brinjal fruits are ready for seed extraction when at least one third of the fruit part turns yellow in colour starting from the stem end. The mature fruits are cut or crushed into small pieces. The seed along with fruit flesh is extracted with fingers and the seed is washed free of food material by washing in water filled tub. The fruit flesh floats over the surface of water. Water and the floating pulp are removed by hand. The clean seed can be obtained by repeated washing in water. Seed should be dried immediately after washing. It is very essential that the seed extraction and its washing should be completed during morning hours so that seed gets sufficient drying during the day and to avoid sprouting of the seed during the night.

Hybrid Brinjal Cultivation

Pusa Hybrid-5: Plants are vigorous, non spiny with semi erect branches. Fruits are long, glossy, attractive, dark purple with partially pigmented peduncle, each fruit weighing 100 g. It takes 80-85 days from sowing to first picking and further pickings continue up to December. Average yield is 520-540 q/ha.

Pusa Hybrid-6: Plants are vigorous, non spiny with semi erect branches. Fruits are round, glossy, attractive, violet purple with partially pigmented peduncle, each fruit weighing 200-250g. It takes 85-90 days from sowing to first picking and further pickings continue upto December. Average yield is 450-470 q/ha.

Arka Navneet: High yielding F1 hybrid with large (450g) purple oblong fruits. Average yield is 650-750 q/ha.

Kashi Komal: Plant height is 90-100cm with green stem and leaves. Fruits are light purple, long, soft textured, avg. length is 13 cm, diameter is 30 cm. The picking starts in 65-70 days after transplanting. Average yield is 800 q/ha

Kashi Sandesh (VRBHR-1): Plant with green stem and purplish green leaves. Fruits are purple, medium round, soft textured, average length is 12.4 cm, diameter is 10.2 cm. The picking starts in 76 days after transplanting. Average yield is 780 q/ha.

MHB-10 (Kalpataru)

MHB-10 has been developed by Mahyco Vegetable Seeds Ltd., Jalna. Plants are erect, bushy, compact and spiny. Fruits are round to slight oval, shining reddish purple with white streaks (bicolour), green spiny calyx; weight of 60-70 g; first picking starts on 70-75 days after transplanting; gives yield of 400-500 q/ha.

Manju

This hybrid has been developed by Syngenta India Ltd., Pune. Plants are strong, bushy with medium height, dense green foliage and sparingly leaves. Fruits are small, oval-round, light purple with white stripes, less seed and less spiny on large calyx; average weight of 80-100 g.

Spacing: 90 x 90cm

Seed rate: 200-250g/ha

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (420.0)	100 (220.0)	80 (136.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at 30 days interval after transplanting.

Yield: 600-800 q/ha

2.3 Chilli (*Capsicum annuum* L.)

Chilli or hot pepper is a tropical vegetable crop commonly used throughout the world as a spice for its pungency and red colour of ripe dried fruits and also for its green fruits for pungency and flavor. The flavor/pungency in chilli is due to capsaicin and oleoresin where as red colour is due to the pigment capsanthin. It also contains fair amount of vitamin (A & C), phosphorus and crude fibre.

Climate

It performs well in warm humid tropical and subtropical regions. Optimum temperature for its successful cultivation is 20-33°C. Extreme temperature (below 15°C and above 35°C) significantly reduce the reproductive growth and pollen viability. Humidity favours vegetative growth but frost is injurious. Low temperature at fruit ripening stage likely to delay colour development in fruits. It performs well in areas with annual rainfall ranging from 600 -1200 mm spread over 4-5 months.

Soil

It can be grown in almost all types of soils ranging from sandy loam that are well drained to heavy clays rich in organic matter. The pH should be around 6.5-7.5.It can also tolerate salinity to a considerable extent.

Varieties

Pusa Jawala: Plant are dwarf, bushy, light green, fruits 9-10 cm long, light green, ripe fruits are light red, highly pungent, fairly tolerant to thrips and mites, Average yield is 85 q/ha(green) and 18 q/ha (dry).

Pusa Sadabahar: Plant are erect, perennial, 60-80 cm tall bushy, fruits 6-8 cm long, borne in clusters with 6-14 fruits per cluster, ripe fruits are dark red, highly pungent, resistant to CMV, TMV and leaf curl complex, First picking starts in 75-80 days after transplanting. Average yield is 95 q/ha(green) and 20 q/ha (dry).

Pant C-1: Fruits highly pungent, small in size, broader at the base, moderately resistant to mosaic and leaf curl virus. Average yield is 75 q/ha (green) and 15 q/ha (dry).

Seed Rate: 700-800g/ha

Planting time

Zone		**Seed sowing**	**Transplanting**
Sub-tropical	Ist Crop	November	January
	IInd Crop	February -March	March-April
	IIIrd Crop	May-June	June - July
Intermediate (Low)		March-April	April-May
Intermediate (High)		April-May	May-June.

Seed rate: 700- 800 g/ha

Spacing: 45 x 30 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	100 (206.0)	60 (132.0)	30 (51.0)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 21 and 42 days after transplanting.

Integrated nutrient management

- Apply vermicompost @ 4-6 t/ha as broadcasting during final land preparation.
- Apply Azotobactor and Phosphate Solublizing Bacteria @ 800g/ha as seedling root dip. Prepare a suspension of bacterial inoculants in sufficient water. Dip the seedlings in bacterial suspension in shade for 2-3 hours and transplant immediately.

Irrigation

Chilli needs judicious irrigation for proper growth and yield. Frequent and heavy irrigations induce lanky growth and cause flower shedding. Critical stages of irrigation are tenth leaf to

flower, fruiting and after periodical harvests. During summer, apply irrigation at 4-5 days interval and during winter at 10-12 days interval. Furrow method is the most common method of irrigation.

Weeding and hoeing

Practice shallow inter - cultivation particularly a few days after every irrigation to remove the weeds and to conserve the moisture. 3-4 hoeings are normally needed to check the weeds growth. Earthing up the seedlings 21 days after transplanting after first top dressing of nitrogen is quite beneficial. Regarding chemical weed control, a pre plant application of Fluchloralin (Basalin 48 EC) @ 1.0-1.5 kg a.i/ha followed by one hand weeding 30 days after transplanting is effective.

Harvesting

Harvesting of chillies depends upon the type and purpose for which they are grown. The picking of fruits may be started 60-70 days after transplanting. Ripe fruits are picked at an interval of 1-2 weeks and harvesting continues over a period of about 3 months. The number of pickings varies from 6-10 depending upon the season, cultivar and cultural practices. The packaging used for transportation should have airy ventilation and gunny/jute bags are used.

Storage

Green chillies can be stored in the cold storage up to 40 days at 0°C and 95-98% relative humidity. For dry chillies, harvest the fruits when fully ripe and partially withered on the plant itself. Keep the harvested fruits in heaps either indoor or in shade away from direct sunlight for 2-3 days to develop uniform red colour. Dry the red ripe fruits in the sun for 8-15 days depending upon the weather condition on clean dry polythene sheets, cemented/ concrete drying yards etc.Spread the pods in thin layers for uniform drying with frequent turning to prevent mold growth and discoloration. Heap and cover the dried pods by clean gunny bags or polythene sheets. The moisture content of the dry pods is to be kept at 8-10%.

Yield: 70-100q/ha (Green) 15-25q/ha (Dry)

Chilli Seed production

Chilli is an often cross pollinated crop so minimum isolation distance of 400 m. between two varieties should be maintained. A seed crop should be inspected at different stages of maturity to ensure the genetic purity. The first inspection should be done before flowering and off type/ extra early plants should be removed. The second inspection should be conducted at full bloom and fruiting stage and the plants which do not confirm the varietal purity such as fruit shape, colour, position of fruit, flower colour, plant spread and leaf characteristics like leaf colour and shape etc. should be removed. The third inspection should be done just before fruit picking and only true to type plants are retained for seed harvest. Red ripe fruits are harvested and dried under sun. The seeds are extracted manually on small scale and with axial-flow seed extractor on commercial scale.

Physiological disorders

Flower/Fruit drop: It is one of the major constraints in chilli cultivation. It may be caused due to:

- Low humidity and high temperature conditions.
- Decreasing light intensity and Short day during early flowering stages.

Control measures

- Irrigation at flowering and fruit set stage reduces blossom/fruit drop.
- Foliar application of 50 ppm NAA at full bloom stage effectively controls the drop.

Hybrid Chilli Cultivation

CH-1: It is a hybrid between MS-12 x LLS. Fruits are of medium size (6.62 cm long) and weigh 2.7 g each. This hybrid is tolerant to viral and fungal diseases. Its fruits are highly suitable for drying and fresh table purpose. Average yield of red ripe fruit is 200 q/ha.

CH-3: It is a hybrid between MS-12 x S-2530. It is an early maturing hybrid with dark green foliage and pendant fruits. Fruits are dark green when immature and attain deep red colour at maturity. Fruits are long (8.20 cm), mild in pungency with high dry matter content. The deep red coloured fruits make it specially suitable for making chilli paste. Average yield of red ripe fruit is 225 q/ha.

Tejaswani: This hybrid was developed by Mahyco Vegetable Seeds Ltd., Jalna. Plants are bushy with 70-80 cm of height and bear pendant fruits. Fruits are dark green (turn dark red at maturity), 9-11 cm long, highly pungent; suitable for both green and red fruit production; first picking starts on 75-77 days after transplanting; gives an average green fruit yield of 30 t/ha.

NS-101: Namdhari Seeds Pvt. Ltd., Bangalore, has developed this hybrid. Plants are prolific bearing with dark green foliage providing a good foliage cover. Fruits are dark green (turn dark red), medium long (10-12 cm) and medium pungent; suitable for green fruit production; first picking starts on 70-75 days after transplanting; gives an average green fruit yield of 30 t/ha.

Spacing: 75x60cm

Seed Rate: 350-400g/ha

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	150 (315.0)	80 (176.0)	80 (136.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at 30 days interval after transplanting.

Yield: 150q/ha (Green) 30-35q/ha (Dry)

2.4 Capsicum/ Sweet Pepper (*Capsicum annuum* L.)

Sweet pepper or capsicum or bell pepper requires slightly cooler climate than hot chillies and is grown throughout the world for its thick and fleshy fruits having delicate flavor and taste. It is mostly consumed both in green matured and ripe form raw, in salads, cooked, mixed and stuffed vegetable. It is particularly rich in vitamin A and C thus act as potential antioxidant.

Climate

It performs well in mild climate hence, considered a cool season crop. A temperature ranging from 26-28°C during daytime and 16-18°C at night is ideal. It cannot withstand extreme temperature, below 15°C and above 30°C significantly reduce growth and fruit set. It is quite susceptible to frost. Being sensitive to environmental factors, its cultivation under poly-tunnels or poly-houses is preferred.

Soil

A well drained red loamy and alluvial soils with slightly acidic pH is considered ideal for sweet pepper cultivation. On sandy loam soils, it can be grown successfully with proper manuring and timely irrigation. The pH should be around 5.5-6.8.

Varieties

California Wonder: Plant are upright, fine flavoured with 3-4 distinct lobes, smooth, thick flesh, deep green, turns bright crimson at maturity, first picking occurs in 90-100 days after transplanting. Average yield is 170 q/ha.

Arka Mohini: Thick fleshed, 3-4 lobed dark green blocky fruits. Avg. fruit weight is 180-200g. Fruits are pendant which turn red at ripening. Average yield is 200 q/ha.

Arka Gaurav: Thick fleshed, 3-4 lobed dark green blocky fruits. Avg. fruit weight is 130-150 g. Fruits are erect which turn orange yellow at ripening. Average yield is 160 q/ha.

Arka Basant: Thick fleshed, 2-3 lobed conical fruits. Avg. fruit weight is 50-80 g. Fruits are erect cream coloured which turn orange red at ripening. Average yield is 150 q/ha.

Planting time

Zone	Seed sowing	Transplanting
Sub-tropical	End of October	Mid February
Intermediate (Low)		

Seed rate: 300 g/ha

Spacing: 45 x 45 cm.

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	120 (260.0)	70 (154.0)	30 (51.0)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses, at 21 and 42 days after transplanting.

Integrated nutrient management

- Apply vermicompost @ 4-6 t/ha as broadcasting during final land preparation.
- Apply Azotobactor or Phosphate Solublizing Bacteria @ 800g/ha or Azospirillium @ 2kg /ha as seedling root dip. Prepare a suspension of bacterial inoculants in 10 litres of water. Dip the seedlings in bacterial suspension in shade for 30 minutes and transplant immediately.

Irrigation

Capsicum needs judicious irrigation for proper growth and yield. Frequent and heavy irrigations induce lanky growth and cause flower shedding and reduce yield. Critical stages of irrigation are flowering, fruiting and after periodical harvests. In sandy loam soils, it is best to provide irrigation at 605 soil moisture depletion level in the top 30 cm soil profile. In winter season irrigation is applied at 12-15 days interval. Average consumptive use is 446 mm. Most adopted method of irrigation is furrow method and under poly house condition drip irrigation is beneficial.

Weeding and hoeing

Practice shallow inter - cultivation particularly a few days after every irrigation to remove the weeds and to conserve the moisture. 3-4 hoeings are normally needed to check the weeds growth. Earthing up the seedlings 25 days after transplanting, after first top dressing of nitrogen is quite beneficial. Regarding chemical weed control, a pre plant application of Fluchloralin (Basalin 48 EC) @ 1.0-1.5 kg a.i/ha followed by one hand weeding 30 days after transplanting is effective. Judicious pinching of flowers produce 8-10 big fruits of 90-100 g weight per plant. Provide stake to plants to produce fruits free from blemishes.

Harvesting

Pick the large sweet peppers when they are still green and full grown, firm and crisp. Red and yellow varieties can be harvested at the onset of colour change. Harvesting of sweet peppers starts 35-50 days after flowering depending on the variety. It can be done once in 10-12 days with 5-6 pickings in open pollinated varieties and 8-10 pickings in the hybrids. Pick the fruits with an upward twist with a piece of stem intact. The packaging used for transportation should have air holes for ventilation.

Storage

The harvested fruits are kept in shade to avoid sun scald. Immediate pre-cooling by immersing preferably in ice cold water enhances shelf life. The fruits are wiped, cleaned in fresh water, graded in size and packed in wooden boxes, paper cartons or plastic crates before marketing. It can be stored up to 14-21 days at 7°-10°C with high RH and for 40 days at 0°C and RH of 95-98% with minimum shrinkage.

Physiological disorders

Flower/Fruit drop: It is one of the major constraints in sweet pepper cultivation. It may be caused due to:

- Low humidity and high temperature conditions.
- Decreasing light intensity and
- Short day during early flowering stages.

Control measures

- Irrigation at flowering and fruit set stage reduces blossom/fruit drop.
- Foliar application of 50 ppm NAA at full bloom stage effectively controls the drop.

Skin cracking: Cracking occurs around the shoulder of the fruits. Fluctuations in temperature and humidity are responsible for this disorder. High day temperature and average relative humidity increase the incidence of cracking.

Sun scald: Soft, light coloured area appears on the fruit, which becomes slightly wrinkled, slightly sunken and papery later on. It occurs when the fruits are exposed to scorching sun light.

Blossom end rot: Water soaked spots appear at the blossom end which becomes light brown and papery as the lesions dry out. Heavy irrigation after a period of low soil moisture condition and heavy application of nitrogenous fertilizers causes this disorder.

Control measures

- Judicious and timely irrigation.
- Application of judicious amount of P and K fertilizers along with N fertilizers.
- Two foliar sprays of 0.2% calcium chloride at the time of fruit development.

Hybrid Capsicum Cultivation

Pusa Deepti: This hybrid has been developed by lARl Regional Station Katrain. Plants are bushy, vigorous, 55-65 cm in height with erect bearing habit. Fruits are light green and conical with thick flesh; first picking starts on 70-75 days after transplanting; tolerant to bacterial leaf spot, anthracnose and high temperature; gives yield of 35-50 t/ha.

Indira: This F1 hybrid has been developed by Syngenta India Seeds Ltd., Pune. Plants are medium tall with vigorous growth and dark green foliage, which provide shelter to the fruits. Fruit are dark green, thick walled, 3-4 lobed and glossy with average length and weight of 11 cm and 170 g, respectively; first picking starts on 60-65 days after transplanting; gives yield of 30-35 t/ha; good keeping quality.

Bharat: This hybrid was developed by IASH, Bangalore. Fruits are blocky (3-4 lobes), well-shaped, thick walled with an average length and diameter of 8 and 10 crn, respectively, average weight of 150 g resistant to tobacco mosaic virus; gives yield of 30-35 t/ha.

Lario: This hybrid has been developed by Syngenta India Ltd., Pune. Plant are medium tall, compact, vigorous, dense foliage provides adequate shelter to fruits and requires stacking. Fruits are of medium size, dark green, thick walled, fleshy and blocky (3-4 lobes) with average fruit weight of 150 g; first picking starts on 60-65 days after transplanting; gives yield of 30-35 t/ha.

Seed rate: 250 g/ha

Spacing: 75-80 cm x 30-45 cm.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (420.0)	150 (330.0)	100 (170.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at 30 days interval after transplanting.

2.5 Insect-pest management in solanaceous vegetables

Cutworm *(Agrostis* spp.)	
The damage is caused by caterpillars by cutting the plants in the nursery and during early stage of transplanting. Damage is caused during night. The caterpillars cut more plants than they actually feed.	1. Irrigate the vegetable beds, collect the caterpillars from the standing water and destroy them. 2. Soil treatment before sowing by dusting of Chlorpyriphos 1.5% D @20kg/ha or Broadcasting of carbofuron 3G @ 30 kg per ha or cartap hydrochloride 4G @ 25 kg/ha
Mealy bugs, *Phenacoccus solenopsis*	
Mealybugs are emerging insect pests found infesting on leaves, stems and fruits of tomato, brinjal and okra in Jammu region. They are covered with white wax, which makes them difficult to control. Both nymphs and adults suck the sap from leaves causing withering and yellowing of leaves. Heavy infestation can cause defoliation and even death of the plants.	1. The crop residues in earlier infested fields should be removed and burnt. 2. Soil raking and field sanitation (free from weeds and debris) should be followed. 3. Spray dichlorvos 76 EC 2 ml/l, chlorpyriphos 20 EC 2.5 ml/l, imidacloprid 200 SL 0.3 ml/l or malathion 2.0ml/l of water at 15 days intervals.

Whiteflies, *Bemesia tabaci*	
The adults and nymphs suck sap from the leaves of the host plants and reduce the vitality of crops. They often congregate on the underside of leaves act like vector for transmitting the tomato leaf curl virus in tomato. Severe stunting of plant with downward rolling, crinkling of leaves and severe chlorosis of newly formed leaves takes place. Older leaves become leathery and brittle in severe infestation of white flies.	1. Seed treatment with Imidacloprid 70 WS @ 3g per kg of seed to protect the crop from infestation up to 30-35 days. 2. Nursery crops should be covered with nylon net (200 mesh size) for 30 days. 3. Removal of weed hosts. 4. Use of delta traps or sticky traps @ 10/ha for effective catching of whiteflies. 5. Foliar spray of imidacloprid (0.3 ml per lit) during the vegetative stage of the crop (before flowering) or root dip of tomato seedlings in imidacloprid @ 0.3 ml per lit of water for half an hour 6. Need based application of metasystox @ 1.0 ml or dimethoate or rogor (2ml/lit) after flowering.
Jassids (*Amrassca devastans*)	
Both nymphs and adults suck the sap from the leaves and cause shriveling of leaves. It is also a vector of virus diseases.	1. Seed treatment with thiamethoxam 70 WS @ 3g/kg seed or Imidacloprid (Gaucho) @ 5g /kg seed before sowing. 2. Use of delta traps or sticky traps @ 10 /ha 3. Foliar spray of imidacloprid (0.3 ml/lit) during the vegetative stage of the crop (before flowering) 4. Sparying of metasystox 25 EC @ 1 ml/lit or rogor 30 EC @ 2 ml/lit or malathione 50 EC @ 2 ml/lit after flowering.
Aphids (*Aphis spp*.) (*Aphis spp.)*	
The damage is caused both by nymphs and adults, which suck the sap from leaves, the plants become sick.	1. Use Yellow sticky traps @ 10/ha 2. Spray 2 ml of Malathion 50 EC per lit of water or imidacloprid @ 0.3 ml /lit or of water or Methyl demeton 25 EC@ 1 ml/lit or Dimethoate 30 EC @ 1L/ha as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Tomato leaf miner	
Leaf miners cause heavy leaf mining on upper or lower side of the leaves. Mines starts From the margins of leaves and progress towards the base/centre of leaf. Severe leaf mining slows down the plant growth & accelerates the leaf drop.	1. Judicious application of nitrogenous fertilizers 2. Removal and destruction of infected leaves 3. Spraying with Imidacloprid 17.8 SL @ 0.3 ml/lit of water during early stage of crop before flowering. 4. After flowering or in full bloom, spray Nuvon / DDVP @ 2ml/lit or dimethoate @ 2 ml per lit of water in case of severe infestation are found to be effective against leaf miner.
Fruit Borer (*Helicoverpa armigera*)	
The caterpillers initially feed on leaves and later bore into the fruits making them unfit for consumption.	1. Deep summer ploughing to expose the hibernating pupa for sunlight and predation by birds 2. Planting on row of marigold (40 days old) as a trap crop for luring the adults to oviposite 3. Installation of pheromone traps @ 5-7 per ha for early detection and12-15 per ha for trapping and mass mating disruption.

	4. Sparying of *Bacillus thuringiensis* powder @ 2g per lit of water. 5. Foliar spray Ha-NPV 300 to 500 LE/ha (1 ml/lit) freshly procured and mixed with 10 g/lit gur or jaggary and tinopal blue (1ml/lit) for 2-3 times at 12 days interval at evening hours. 6. Need based and alternative application of fenvalerate 20EC @ 1 ml/litl or deltamethrin 2.8EC @ 1 ml/litl of water followed by dimethoate or rogor (2 ml/lit of water)
Root knot nematode *(Meloidogyne spp.)*	
Pest of brinjal, tomato, potato and other solanaceous plants. Due to the attack of nematodes the leaves turn yellow patchy. On roots knot like galls are formed.	1. Follow crop rotation and grow marigold in nematode infested area 2. Broadcast Carbofuran, 3G@ 30 kg/ha or cartap hydrochloride 4G @ 25 kh/ha at the time of last ploughing
Snails	
The snails feed on leaves and stem, lives in cool moist shady and dampy places. Serious pest of vegetables in Batote area during summer and rainy seasons.	1. When sufficient number of snails are observed in the fields 2. Dusting of 1.5% Metaldehyde or 20% Metaldehyde liquid or 5% Metaldhyde pellet or Methiocarb 4% bait
Slugs	
The slugs make irregular holes on the leaves and ripe fruits. They cause heavy damage when they attack the young plants.	1. When sufficient number of slugs are observed in the fields 2. Place 0.1% Carbaryl @ 1.5kg/ha or 2-3% Metaldelhyde mixed with bran in small heaps when the soil is moist
Hadda Beetle (*Henosepilachna* spp.) Both grubs a rid adults cause damage which feed on the epidermis of leaves. The leaves turn papery as the chlorophyll is destroyed.	1. Collection and destruction of eggs, grubs, and pupae from leaf surfaces 2. Sparying of Carbaryl 50WP (2 g/litre of water) or Acetamiprid 20 SP@ 0.3 ml/lit or Malathion 5% dust @ 20-25 kg/ha
Brinjal shoot and fruit borer (*Leucinodes orbonails*) The Cater pillcrs bore into shoots and fruits. The holes remain plugged with black excreta. The affected shoots drop and wither away. The attack is more severe during rainy seasons.	1. Regular clipping of the infested shoots and fruits and destroy them or buried in a pit 2. The moths can be mass trapped by installation of pheromone traps/wota or water traps @ 100 per ha at 10 m spacing after 15 days of transplantation. 3. Plant two lines of border row of sounf /coriander for encouragement of natural enemy fauna for natural control 4. Spraying the crops alternatively with profenophos 50 EC @ 2ml /litre of water and flubendiamide (0.2 ml or g/lit of water) or methomyl 40 SP @ 2 g/lit or cypermethrin (1 ml/litre of water) at 15 days interval starting from 20 days after transplantion to control the brinjal shoot and fruit borer.

Brinjal stem borer (*Euzophera perticella)* (*Euzophera perticella*) Damage ic; done by newly hatched caterpillar. They feed on exposed parts of the plants for few minutes, later on they bore into the stem and moves down wards and feed on the pith hand make longitudinal tunnels as a result of which plants droop down and finally die.	1. Infested plants should be pulled out and destroyed by burning. 2. Avoid ratoon cropping 3. Application of neem cake @ 500 kg/ha or carbofuron @ 1.25 kg/ha at the time of transplantation around the base of the plant.
Spider mite (*Tetranychus* spp.)	
Spider mites attack the leaves suck the cell sap and ultimately cause defoliation.	1. Acaricides like dicofol 18.5EC (2.5 ml/lit) and wettable sulphur (2 g/lit) or propargite 57EC @ 3 ml/lit of water gives effective control of red mites in brinjal.
Termites *Microterrncs spp*.	
The worker class of the termites cause damage by feeding on the roots and the stem. The plants do not grow properly, wilt and soon dry up.	1. If attack is noticed in standing crop, apply chlorpyriphos 20EC @ 4 litres with irrigation water
Thrips (*Scrictothrips dorsalis*)	
Both nymphs and adults scrap the tissues and suck the sap from leaves resulting into curling of leaves and stunted growth	1. Seed treatment with imidacloprid (Gaucho) @ 5 g per kg seed. 2. In the field, foliar spray with imidacloprid @ 0.3 ml/lit of water or fipronil @ 2 ml per liter or thiomethoxam @ 0.3 ml/lit of water before flowering. 3. Spraying of metasystox 25 EC @ 1.0 ml/lit or rogor 30 EC @ 2 ml/lit or malathione 50 EC @ 2.0 ml/lit during flowering and fruiting.
Chilli Yellow Mites	
Mites attack the leaves suck cell sap and cause ultimately defoliation.	1. Sparying of dicofol @ 3 ml/lit or wettable sulphur @ 2 ml/lit or propargite @ 4.0 ml/lit or vertimac 1.8 EC@ 0.3 ml/lit of water alternatively at an interval of 15 days. 2. Choose any two and spray alternatively

2.6 Disease Management in Solanaceous Vegetables

Damping off (*Pythium Phytophthora, Fusarium, Rhizoctonia spp.)* Seedlings are killed at the pre and post emergence stages and diseased seedlings topple.	1. Partial sterilization of the soil may be done by burning 10-12 inch thick stack of farm trash on the nursery bed.
	2. Treat will prepared nursery beds after adding manure with formalin (1 part formalin: 7 parts of water) and cover the treated beds with alkathene for 15-20 days before sowing. The seeds should be sown only when the soil becomes free from formalin vapours. About 5 litres of formaline solution is sufficient to drench 1 sq. mt. area.
	3. Use the seeds treated with captan or thiram (2-2.5g/kg seed)
	4. Drench the nursery beds with the fungicide combination of carbendazin and mancozeb (0.25%) at the initiation of damping off symptoms

Tomato

Buck eye rot: (*Phytophthora nictianae var. parasitica*.)	
Brown spots with light and dark concentric zonations appear on green fruits.	1. Adopt field sanitation, and crop rotation. 2. Use the treated seed 3. Give staking to tomato plants and prune out lower leaves upto 30 cm height just before onset of monsoon and apply one prophylactic spray with the combination of metalaxyl and mancozeb (0.25%) 4. Collect rotten fruits and destroy them. Spray the crop with mancozeb (0.25%) or copper oxychloride (0.3%) at 10-15 days.
Septoria leaf blight: *(Septoria lycopersici)*	
Attack is earliest on older leaves. Small, circular and water soaked spots appear on the surface. On upper surface minute fungal fruiting bodies are seen. Disease spread from lower to upper leaves	1. Seed treatment with Thiram (2g/kg of seed) 2. Field sanitation 3. Crop rotation may be adopted
Early Blight: *(Alternaria solani)*	
In case of Alternaria diseases concentric or brown spots appear on leaves which induce yellowing. Fruits also show similar symptoms. While different types of small to medium light brown to dark spots appear on foliage, with other defoliating diseases resulting into premature leaf fall & exposure of fruits to sun burn.	1. Get seed from healthy plants 2. Treat the seed with thiram (3g/kg) or carbendazim (1 gm/kg seed 3. Spray the crop with mancozeb (0.25%) or copper oxychloride (0.3%)on appearance of diseases
Bacterial wilt: *(Pseudomonas solanacearum)*	
Wilting, stunting, yellowing of foliage and finally the entire plant collapses. Vascular system becomes brown but roots are healthy.	1. Follow 3 year crop rotation in infested field by including non host crop 2. Always transplant disease free seedlings

Bacterial canker: *(Corynebacterium michiganensis)*

Lower leaves wilt, on stem brown streaks and canker develop and small brown scaby lesions surrounded by white appear on fruit.	1. Use disease free seed 2. Follow 3 year crop rotation in infested field by including non host crop 3. Remove diseased plants and destroy them
Viral diseases (leaf curl, mosaic and tomato spotted wilt virus) Symptoms are self explanatory as per nomenclature terms used. In case of tomato spotted wilt, brown coloured markings on upper side of young leaflet and tender stem, followed by curling, stiffening. In severe cases, the plants wilt and wither.	1. Always use virus free seedlings. Rogue out infected plants in early stages of infection and destroy them. 2. Remove reservoir hosts (weeds such as *Datura stramonium*) 3. Spray imidacloprid (0.5ml/litre) or thiomethoxom (0.03%) for vector control from nursery growing to pre-flowering stage in infested areal season. Use healthy seed for the control of mosaic 4. Growing tomato nursery under insect proof net houses.

Brinjal	
Phomopsis blight (*Diaporthe vexans*): Brown lesions phomopsis vexan develop on leaves and shoots. Infected fruits show brown discoloration.	1. Seed treatment with thiram (2g/kg seed) 2. Spraying with mancozeb (0.25%) or copper oxychloride (0.3%)
Phytophthora fruit rot (*Phytophthora parastica*): Fruit start rotting from the apical portion.	1. Treat the seed before sowing with thirarn (3g/kg seed) 2. Spray the crop with 0.25% zineb or mancozeb (250g/ 100 1itres of water) or Copper oxychloride (0.3%) 3. Collect and burn plant debris.
Little leaf (*Phytoplasma)*	
In infected plants, leaves are reduced to very small size resulting in stunted growth and bushy appearance; plants fail to bear any fruit. The disease is transmitted by leafhopper (*Hishimonus phycitis*)	1. Eradication of infected crop plants 2. Spray malathion (2 ml/litre of water) starting with the appearance of leaf hopper to control their population
Chilli	
Die-back and fruit rot (*Colletotrichum capsici*)	
Necrosis of twigs from tip to backward. Black spots (fungal accrvali) are seen all over the affected surface. Circular spots on the fruit appear which become elliptical in shape. Rotting of the fruit starts in the field and may continue after harvesting in transit and storage.	Give a prophylactic spray of combination of metalaxyl and mancozeb 0.25% (250g per 100 L water), Just before the onset of monsoon followed by spray with copper oxychloride @ 0.3% at 10-15 days interval.
Chilli wilt complex (*Fusarium*, *Phytopthora*, *Pseudomonas*)	
Disease is favoured by edaphic factors especially high soil moisture and poor drainage conditions. The wilt complex includes root rot, collar rot and true wilt symptoms with sudden death. The disease is in alarming proportions in certain season in traditionally chilli growing belts in temperate, intermediate as well as sub-tropical areas and results into complete failure of crops in certain belts. The wilt complex usually appears severe with the onset of monsoon when plants are in bearing state, indicating high sensitivity to high soil moisture. The chill wilt complex is usually confused with attack of foliar blights at later stages by the growers.	1. Plant resistant/ tolerant varieties. 2. Give seed treatment with metalaxyl + (2.5 g/kg of seed mancozeb or thiram @3g/ kg seed. Raise the seedling in the nursery as discussed under tomato damping off. 3. Apparently healthy seedlings are dipped in solution of carbendazim 0.1 % + streptocycline (100 ppm) for 30 minutes before transplanting. 4. Transplant the seeding in well drained field and provide need based irrigation without allowing water stagnation. 5. In disease prone areas, the field/plot should be rotated with non-solanacesous crops.
Leaf curl (chilli leaf curl virus)	
Curling and yellowing of leaves are the main symptoms of the disease stunting of the plants is observed.	It can be managed by spraying with any systemic insecticide.

3. Okra/Bhindi (*Abelmoschus esculentus* Moench.)

Okra is an important annual vegetable crop in tropical and subtropical parts of the world. It is mainly used for its tender green fruits as vegetable. It is a rich source of iodine, calcium, sulfur and sodium. Its tender fruits also contains vitamin-A, C, thiamine and riboflavin. Besides it also has dietary fibres, proteins and carbohydrates.

Climate

It is basically a hot weather crop and thrives well during hot and humid climatic condition. It can be successfully grown under the temperature ranging between 25-30°C. It is susceptible to draught, frost and low night temperature. Day temperature more than 42°C causes flower drop. Optimum temperature range for seed germination is 25-35°C and seed do not germinate below 17°C. Adequate sun shine is very important for growth and yield of the crop.

Soil

It can be grown in wide range of soil, sandy to clay loam with enough organic matter and having good drainage facility however, loose, friable, well manured loamy soils with a pH range of 6.0-6.8 are best for its cultivation. Water logging is harmful for the crop.

Varieties

Pusa Sawani: Fruits are smooth with 5 ridges, dark green and 18-20 cm long when fully developed. It is distinguished by the presence of a purple patch at the base of the yellow petal on both the sides. It is suitable for cultivation in spring - summer season in plains. Average yield is 150-175 q /ha.

Pusa A-4: Fruits are smooth, dark green and 12-15 cm. long when fully developed. It is tolerant to YVM and aphids. First picking starts in 45 days. Average yield is 140 q/ha.

Arka Anamika: Fruits are lush dark green, tender and long, free from spines, having 5-6 ridges with delicate aroma. Possesses good keeping and cooking qualities. Field tolerant to YVMV. Average yield is 200 q /ha.

Varsha Uphar: Plants are medium tall, suitable for rainy season cultivation, fruiting starts on third/fourth node, resistant to YVMV. Average yield is 90-100 q/ha.

Hisar Unnat: Suitable for rainy season cultivation, fruiting starts on third/fourth node, resistant to YVMV. Average yield is 100-110 q/ha.

Hisar Naveen: Suitable for rainy season cultivation, high yielding variety, tolerant to YVMV. Average yield is 110-120 q/ha.

Sowing

Zone	**Sowing time**
Sub-tropical	February- March (Spring-summer crop) June - July (Rainy season crop)
Intermediate (low)	March - May
Intermediate (high)	April - May

Seed sowing

Soak the seed overnight in water for better germination. Soaking the seed in 0.2% Bavistin overnight protect the seedlings from wilt.

Seed rate

- For Spring- Summer Crop: 20-25 kg/ha
- For Rainy Season Crop: 12-15 kg/ha

Spacing

- Spring - summer Crop: 45 x 30 cm
- Rainy season Crop: 60 x 45 cm

Manures and Fertilizers

FYM ***(t/ha)***	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP)** ***kg/ha***
25	100 (205.0)	60 (132.0)	60 (102.0)

- Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses, at 30 days after sowing and at flowering.
- For the ratoon crop, same nutrient schedule is followed and basal dressing should be done immediately after pruning followed by irrigation and plant protection measures.
- In spring summer season, application of N in splits after every 3-4 pickings increases the crop duration and yield.

Integrated nutrient management

- Foliar spray of 0.3% Zinc sulphate and 0.02% Ammonium molybedate in the standing crop enhance fruit yield. Soil application of Calcium is beneficial for seed crop.
- Apply Vermicompost @ 4-6 t/ha as broadcasting during final land preparation.
- Apply Azotobactor or Phosphate Solublizing Bacteria @ 800g/ha as seed dip. Prepare a suspension of bacterial inoculants in 10 litres of water. Soak the seed for 2-3 hours and dry in shade.

Irrigation

Seed should be sown in optimum moisture conditions. Apply water at the initiation of first true leaf during spring-summer and at its expansion during rainy season. Irrigate the field subsequently at 5-6 days intervals during summer and as and when required in rainy season crop. The crop must be irrigated during its most critical stages i.e. flowering and fruit setting stages. However, over irrigation should be avoided as it causes wilting.

Weeding and hoeing

Proper weed management is needed to check yield loss. At least two weedings are required till the crop canopy covers the soil surface. Regarding chemical weed control, apply fluchloralin (Basalin 48 EC) @ 1.5 kg a.i/ha as pre-sowing soil incorporation and pendimethalin (Stomp 30 EC) @ 0.75 kg a.i/ha as post sowing and pre-emergence soil surface spray. The surface application of these herbicides is effective for 4-5 weeks.

Harvesting

First harvesting is generally done 40-50 days after sowing depending on the variety. Harvest the tender fruits by bending the pedicel with a jerk or with the help of a knife at every alternate day. Use cotton cloth gloves to protect fingers and harvest in the morning for local market and in

late evening for distant markets. For local markets pre-cool the fruits by dipping in cold water and fill in jute bags or baskets and sprinkle water on them. For distant markets the pre-cooled fruits of graded size are packed in perforated paper cartons.

Storage

The fruits can be stored at 7-9°C temperature and 80-90% relative humidity for 7-10 days.

Hybrid Okra Cultivation

HBH-142: High yielding hybrid**,** suitable for rainy season cultivation, fruiting starts on third/ fourth node, resistant to YVMV.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
30	200 (420.0)	100 (220.0)	100 (170.0)

Apply half N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 30 days interval after sowing.

Spacing: 60 x 60cm

Seed rate: 20kg/ha

Yield: 250q/ha

3.1 Insect-pest management in Okra

Maggots and White grubs	1. Broadcasting of Quinalphos 5G @25kg/ha at the time of sowing or carbofuron 3 G @ 30 kg/ha at the time of land preparation.
Jassids	1. Seed treatment with thiamethoxam 70 WS @ 3g/kg seed or Imidacloprid (Gaucho) @ 5g /kg seed before sowing. 2. Use of delta traps or sticky traps @ 10 /ha 3. Foliar Spray of imidacloprid (0.3 ml/lit) during the vegetative stage of the crop (before flowering) 4. Sparying of metasystox 25 EC @ 1 ml/lit or rogor 30 EC@ 2 ml/lit or malathione 50 EC @ 2 ml/lit of water after flowering.
Aphids	1. Use Yellow sticky traps @ 10/ha 2. Spray 2 ml of Malathion 50 EC per lit of water or imidacloprid @ 0.3 ml/ lit or of water or Methyl demeton 25 EC@ 1 ml/lit or Dimethoate 30 EC @ 1L/ha as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Shoot and Fruit borer (*Earias* spp.)	1. Installation of Ervitlure @ 12-15 /ha for mass trapping of spotted bollworm on bhendi. 2. Carbaryl 50 WP @ 2 g /lit or cypermethrin @ 1 ml/lit or Malathion 50 EC@ 2 ml/lit of water or methomyl 40 SP@ 2 g/lit of water 3. All the consumable fruits should be picked before spraying
Red cotton bug	Spraying of Acetamiprid 20 SP @ 0.3 ml/lit of water or Imidacloprid 17.8 SL@ 0.3 ml/lit of water or Thiamethoxam25 WG @ 0.3 ml/lit of water
White flies (*Aleurolobus spp.)*	1. Seed treatment with Imidacloprid 70 WS @ 3g per kg of seed to protect the crop from infestation up to 30-35 days 2. Nursery crops should be covered with nylon net (200 mesh size) for 30 days. 3. Removal of weed hosts

	4. Use of delta traps or sticky traps @ 10/ha for effective catching of whiteflies 5. Foliar spray of imidacloprid (0.3 ml per lit) during the vegetative stage of the crop (before flowering) or root dip of tomato seedlings in imidacloprid @ 0.3 ml per lit of water for half an hour 6. Need based application of metasystox @ 1.0 ml or dimethoate or rogor (2ml/lit) after flowering.
Blister bettle (*Mylabris postulate)*	1. Hand picking and destruction 2. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours
Stemborer (*Sphenoptera spp.*)	1. Hand picking 2. Broadcasting of carbofuron 3 G@ 30 kg /ha 3. Carbaryl 50 WP @ 2g /lit of water or Malathion 50 EC@ 2ml /lit of water applied as soon as the 5% dead hearts are observed

3.2 Disease Management in Okra

Seed/Seedling rot: (*Fusarium spp. Rhizoctonia spp. and Phytophthora spp.* Rooting of seeds result into failure of germination or pre-emergence death. Emerged seedlings exhibit dark brown rotting of roots and collar portion with sudden or protracted death or decline.	1. Use of healthy and disease free seeds 2. Management as mentioned in damping off of tomato
Yellow Vein Mosaic: (*Leaf vein mosaic)* Leaf veins turn yellow, with leaf lamina light green. Later on, the whole leaf may turn yellow resulting into stunted growth and reduced setting of fruits which are usually yellowish white in colour. The virus is transmitted by white fly (*Bemisisia tabaci)*. The disease is more severe in rainy season crop than summer crop.	1. Use resistant/tolerant Varieties especially for the rainy season. 2. Spray the crop if needed. With imidacloprid @ 0.03%, especially before fruiting starts in order to check the vector population and rogue out infected plants in early stages.

4. Cucurbits

Cucurbits form an important and a big group of vegetable crops cultivated extensively in the State. This group consists of a wide range of vegetables, either used as salad (cucumber) or for cooking (all the gourds) or for pickling (cucumber) or as dessert fruits (musk melon and water melon) or candied or preserved (ash gourd). They include mostly seed propagated ones, besides few vegetatively propagated ones like pointed gourd (parwal) and also few perennials like chow-chow and ivy gourd (kundsru). The use of cucurbits as food plants is not primarily for caloric, mineral or vitamin values, since they are poor or only modest sources of these nutrients. There are few exceptions like bitter gourd rich in vitamin C, pumpkin containing high carotenoid pigments, kakrol (*Momordica dioica*) high in protein and chow- chow fairly high in calcium.

1. Cucumis (cucumber, musk melon)
2. Citrullus (water melon, round gourd)
3. Lagenaria (bottle gourd)
4. Momordica (bitter gourd)
5. Cucurbita (pumpkin, squash, marrow)
6. Luffa (sponge gourd and ridge gourd)

Climatic requirement

Cucurbits are essentially warm season crops grown mainly in tropical and subtropical regions. In temperate areas forcing of cucumber is done mainly in glasshouses where temperature, humidity, light and CO_2 are controlled. Similarly, river-bed production of early cucurbits during winter months is a kind of indigenous system of vegetable forcing practiced with maximum risks of growing under low temperature conditions.

The growth requirements of cucurbits are generally, long period of warm preferably dry weather with abundant sunshine. They are not adapted to resist even light frosts and will have to be provided with at least partial protection if grown during winter months. There are few specific cucurbits which do not stand extreme dry weather but prefer moderate humid conditions, like chow-chow, pointed and snake gourds. But excessive humid weather will promote diseases like downy mildew, anthracnose and virus diseases and pests like fruit fly. For good fruit quality and sweetness in melons, dry weather during fruit development is necessary.

The average temperature for growth would be around 30-35°C with maximum ranging around 40°C and minimum between 20 and 25°C. Most of the cucurbits germinate well when the day temperature is above 25°C. For normal growth, they require optimum average monthly temperature from 25 to 30°C. Cucumber prefers slightly lower temperature than other cucurbits and hence it is extensively grown in subtropical regions. The melons on the other hand require tropical climate with fairly high temperature of 35 to 40°C during fruit development. Cool nights and warm days are ideal for accumulation of sugars in the fruits. If the nights are warm in summer as in some parts of North India, maturity is hastened. Sarda muskmelon is highly sweet and adapted to this kind of climatic conditions. Cantaloupes are grown during spring-summer and also autumn seasons and these are short duration types maturing within 90 days. In subtropical areas cucurbits are grown mostly in summer as well as in rainy season. In the latter season, vine growth and spread will be very extensive. In the hills, cucumber and summer squash are grown in summer (April-August) and in lower hills, two crops are taken depending on the altitude and location. The perennial cucurbits like pointed gourd *(parwal)* is sensitive to frost and cold temperature, especially below 5°C**.** They overwinter and the roots remain dormant underneath the soil. They can be sprouted in spring with irrigation. Chow-chow requires moderate climate with good humidity. Chow-chow does not stand extreme dry winds during summer and frost in winter. In the case of ivy gourd *(kundusru)* it is well suited to warmer regions.

Sex modification

The principle in sex modification in cucurbits lies in altering the sequence of flowering and sex ratio. Besides the environmental factors, endogenous levels of auxins, gibbereIlins, ethylene and abscisic acid determine the sex ratio and sequence of flowering. Exogenous application of plant regulators can alter the sex ratio and sequence, if applied at 2- or 4-leaf stage-the critical stage at which the suppression or promotion of either sex is possible. Hence modification of sex to desired direction has to be manipulated by exogenous application of plant regulators once, twice or even thrice, at different intervals. High ethylene level is favourable to female sex expression and it is suggested that it promotes the formation of the ovary in cucumber, muskmelon and summer squash but it affects the male flower production in watermelon. The role of auxin is recognized in the early evolution of ethylene. Gibberellins plays key role in promoting male sex expression and is antagonistic to that of ethylene and abscisic acid. In fact,

gynoecious lines of cucumber are maintained by induction of male flowers through sprays of GA3/GA7 at 1500 to 2000 ppm. Now-a-days silver nitrate ($AgNO_3$) at 300-400 ppm has been found to bring about this same modification. In cucumber, maleic hydrazide (MH) @ 50 to 100 ppm, GA3 @ 5 to 10 ppm, 2-chloroethylphosphonic acid (commercially called Ethrel, or Ethephon or CEPA) 150 to 250 ppm; in watermelon, tri-iodobenzoic acid (TIBA) 25 to 50 ppm, boron 3 ppm in bottle gourd, boron 3 ppm and calcium 5 ppm and in sponge gourd, Ethrel 250 ppm have been found useful. These bring about increased yield in terms of number of fruits per plant, but the individual fruit size is slightly reduced, especially in watermelon. This kind of sex modification is more useful and practicable, in crops like cucumber and bottle gourd, here continuous and simultaneous flowering, fruit set and fruit picking take place.

4.1 Cucumber (*Cucumis sativus* L.)

Cucumber is one of the most popular cash vegetable crops and is widely cultivated in the State. It is a trailing or climbing annual, bearing elongated, thick cylindrical fruits of varying sizes and forms. There are numerous varieties under cultivation. Fruits of some of the varieties are 25-38 cm. long and 8-10 cm in diameter with fairly thick rind, while others with thin and smooth rind are also popular amongst the growers. The colour of the fruits varies from pale whitish green to dark green turning brownish yellow or rusty brown when mature. The fruits and seeds have cooling effect and prevent constipation. The seed oil is also used as antipyretic.

Climate

It is basically a warm season crop but is successfully grown in tropical, sub tropical and temperate regions. Optimum temperature range for growth and development is 18-24°C. Seed germinate well at 25°C day temperature. Low temperature causes stunting of growth and poor germination of seeds. Long days and high temperature above 30°C increases the number of staminate flowers and reduce the number of female flowers in the vine.

Soil

Cucumber thrives best in the soils ranging from sandy to heavy clays with good drainage system. For attaining early yields sandy loam soils are preferred where as heavy yields can be obtained from loam, silt loam and clay loam soils. It prefers a soil pH between 6-7 and below 5.5 the cucumber cannot be grown.

Varieties

Japanese Long Green: It is an early yielding variety requiring 45 days only. The fruits are long (30-40 cm) and green skinned. The flesh is light green and crispy. Average yield is 115 -125 q/ha.

Straight Eight: It is also an early and short season variety with white skinned fruit which are medium long, thick straight and cylindrical with round ends. Average yield is 125-152 q/ha.

Poinsette: This variety is quite tolerant to downy mildew, anthracnose and angular leaf spot and mildly tolerant to Fusarium wilt. The fruit are dark green with blunt ends and matures in 60 days. Average yield is 125-150 q/ha.

Kheera Local: It matures in 45 days. The fruits are 20-25 cm long. Skin greenish yellow turns brown on maturity. The flesh is light green and crispy. Average yield is 100-125 q/ha.

Sub Tropical	
▪ Spring-Summer Crop	Mid January- Mid February
▪ River bed crop	Mid January
▪ Rainy season Crop	June-July
Intermediate (low)	March
Intermediate (High)	April – May
Seed rate	2.0-3.0 Kg/ ha
Spacing	
▪ Spring-Summer Crop	1.5-2.0 m x 60-90 cm
▪ River bed crop	2-3 m x 60-90 cm
▪ Rainy season Crop	2-2.5 m x 70-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	40 (75.0)	25 (55.0)	25 (43.0)

Apply half nitrogen along with full P and K and farm yard manure as basal dressing and the remaining nitrogen should be top dressed in two split doses i. e. 25-30 days after sowing and 50-55 days after sowing.

Irrigation

Apply irrigation at the initiation of first true leaf during spring summer and at its expansion during the rainy season. Irrigation at regular intervals of 4-5 days after is very important for spring summer crop. Irrigate the field subsequently at 5-6 days interval during summer season and as and when required during the rainy season. The crop must be irrigated during the critical stages i.e., flower bud development and early fruit development stages. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the plant. Ridge and furrow method is the best method.

Interculture operation

Frequent hoeing and weeding of young vine promote healthy growth and quality fruits. When the vine start spreading weeding may not be needed in between the rows or ridges, since the vine growth can smoother the weeds. The pre emergence application of fluchloralin (Basalin) @ 1.25 kg *a.i*/ha can check the weed population.

Harvesting and storage

The size of fruit should be the indicator of the proper maturity. It should be harvested at tender stage. If the harvesting is delayed dark green skin colour turns to brownish yellow. In small fruited types length of the fruit at edible maturity stage is around 8-12 cm. The cucumbers cannot stand much in transportation. They can be stored for two weeks at 10-11.7°C temperature with 92% relative humidity in the storage. It is better to consume the fruit fresh and immediately after removal from the storage.

Physiological disorder

Preponderance of staminate flowers: The plants are monoecious in sex form hence staminate

and pistillate flowers are borne separately in the same plant and the fruit yield depends upon the number of pistillate flowers. Preponderance of staminate flowers is caused due to

- Excessive nitrogen application
- High temperature conditions
- Long day length
- Over irrigation

Control measures

- Avoid excess use of fertilizers and irrigation.
- Apply nitrogenous fertilizer at proper dose.

Hybrid cucumber cultivation

Pusa Sanyog: Very early fruits, 28-30 cm long, cylindrical, attractive dark green with yellow spines, crispy flesh. First picking in 50 days after transplanting**.** Yield is 200 q/ha

Pant Shankar Khira-1: This hybrid is developed by GBPUA&T, Pantnagar. VInes are about 120 cm long. Fruits are about 20 cm long, cylindrical and green with light strips; first picking starts at about 50 days after sowing; gives average an yield of 20 t/ha; suitable for planting in plains as well as hills. This is popular in Uttaranchal and UP. Seeds of hybrid and parental lines could be obtained from the Division of Vegetable Crops, GBPUA&T, Pantnagar.

Seed rate: 1.5-2.0 kg/ha

Spacing: 2-2.5 m x 60-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	60 (120.0)	37 (82.0)	37 (63.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at the time of vining (25-30 days after sowing), at full bloom (50-55 days after sowing) and after first harvest (75-80 days after sowing).

Yield: 200-250 q/ha

MELONS

These include muskmelons, water melons, long melons, and round melons. Melons are annuals with climbing, creeping or trailing vines of length up to 3 m. The dessert types quench thirst and add to the nutrient content of main diet.

4.2 Muskmelon (*Cucumis melo* L.)

Dessert types of muskmelons are consumed as fruit where as non-dessert types are used as vegetables. Skin may be soft or hard yellow, green, cream or orange in colour and plain, netted or prickly in texture. Flesh inside varies from white to cream-yellow, orange or green. At present most of the commercial types have thin skin and thick orange pulp. Musk melon contains significant amount of dietary fibres and potassium useful in lowering constipation and blood pressure. It is also a good source of vitamin A and folic acid. It has refreshing effect during hot summer months. Good characteristics of a muskmelon are thick skin, thick flesh with good

consistency and flavour, attractive outer colour, small or negligible hollowness of fruit and resistance to diseases like powdery mildew and downy mildew.

Climate

Muskmelon grows well and develops the best flavour and more sweetness under hot and dry climate. It is predominantly a warm season crop but can resist the mild frosts. High temperature, sunlight and dry winds at the ripening stage result in better quality fruits. High humidity and rains lower the sugar content and facilitate the incidence of downy mildew. It requires an optimum temperature range of 70°-80°F with minimum of 65°F and maximum of 90°F. The crop takes about 85-100 days from date of sowing to maturity.

Soil

Muskmelon grows well in soils ranging from sandy loam to clay loam which are friable and well drained. The crop is very susceptible to acidic soils where leaves develop yellowish green colour. The crop cannot be grown successfully below a pH of 5.5, A soil pH between 6-7 is ideal.

Varieties

Hara Madhu: The plant has vigorous growth. Fruits are large sized light yellow in colour with distinct green ribs and very sweet (with 12-15% TSS). The variety is late in maturity and lacks the slip stage. It has small seed cavity when ripe. Average yield is 200 q/ha.

Pusa Madhuras: The fruits are somewhat flattened with green stripes, yellowish and smooth skinned. Flesh is orange, juicy and highly flavoured with TSS between 12-14%. Average yield is 120-160 q/ha.

Punjab Sunehri: The vines are prolific, foliage dark green and average fruit weight is 700-800 g. Skin is brown in colour with intense tinge towards the rind. The crop matures in 90 days. Average yield is about 200-220 q/ha

Sowing time

- River bed cultivation Nov.-Jan.
- Subtropical plains Jan.-Feb.

Seed rate: 1.0 kg/ha (dibbling method)

Spacing

- Spring-summer crop: 2-2.5 m x 60-70 cm
- River bed cultivation: 2-3 m x 1.0-1.5 m

Seedlings production under protection

The raising of musk melon seedlings in polythene bags and their transplantation give mature fruits 20-25 days earlier than the normal sowing. The polythene bags of 15 x 10 cm size and 100 gauge thickness are punched at the base and are filled with a mixture of soil, sand and well rotten farm yard manure in ratio of 2:1:1. For raising nursery for 1 hectare, 12.5-15 kg of polythene bags are required. The seed should be sown in bags in the last week of December or in the first week of January. The bags should be placed near the wall facing the sun in order to give them maximum solar heat. Two seeds should be sown per bag at a depth of 1.0-1.5 cm. Watering can be done with rose can just after the seed sowing. Transplanting should be done when the seedlings are 25-30 days old and should be completed latest by 1st fortnight of February

At the time of transplanting a cut is given on the side of the bag with a sharp knife and the bag is removed. The seedlings are transplanted along with the earth ball and the irrigation is given immediately. Other benefits of this method is early yield, less seed rate (i.e. 250 g/ha) and minimum attack of red pumpkin beetle as the crop grows 15-20 days early.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25-30	120 (250.0)	60 (132.0)	60 (102.0)

Whole of farm yard manure, Phosphorus and potassium and 1/3rd of nitrogen should be applied in two parallel bands 45 cm apart on both the sides of the bed. Prepare channels in between the fertilizer bands. Rest of the nitrogen should be applied to the vines 3-4 weeks after germination prior to earthing-up.

Irrigation

During summer, irrigate the crop every week. The irrigation should be as light as possible. At the time of fruit maturity water should be given when it is very necessary. Over flooding should be avoided as the fruit on coming contact with moist soil gets spoiled.

Interculture

Hoeing and weeding keeps the soil loose and free from the weeds. In the beginning, cultivation can be fairly close o the plants and shallow (5-10 cm). When the vines cover the ground cultivation should be stopped and weeds should be pulled out by hands only.

Harvesting and storage

The fruits of Hara Madhu should be picked when it turns yellow as it lacks the slip stage. In other varieties the fruits should be harvested at usual slip stage (*i.e.* separation of fruits from vine). During rains or wet period the fruit should be turned to avoid fruit rot. Musk melon keeps well for one week at 1.7-3.3°C and 85-90% relative humidity.

Hybrid Musk Melon Cultivation

Punjab Hybrid-1: This is a hybrid between ms-l (a nuclear male sterile line) and Hara Madhu: Plant has long vines with medium green leaves, early in maturity, fruits set close to the base of vine. Fruits are nearly round, sutured with medium retting, average weight of 800g, flesh is orange, flavorsome, 12% TSS, fruits develop full slip stage and rind turns light yellow at maturity, shelf life of 2 days, poor transport quality, gives an average yield of 160 q/ha.

Seed rate: 250 g/ha (Polybag cultivation)

Spacing: 2-2.5 m x 60-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25-30	200 (420.0)	100 (220.0)	100 (170.0)

Apply 1/3rd N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at the time of vining (28-30 days after sowing) and at flowering (45-50 days after sowing).

Yield: 160-170 q/ha

4.3 Watermelon (*Citrullus lanatus* var. lanatus)

It is common man's fruit, delicious, nourishing and exerts a cooling effect in hot summer months. It is a rich source of lycopene and beta carotene, the powerful antioxidants.

Climate

Watermelon requires a relatively hot dry climate and long growing season preferably with warmer days and cooler nights. It cannot withstand frost or very low temperatures. For seed germination optimum moisture and soil temperature between 25-30°C is needed. The plant growth is optimum under 28-30°C while the fruiting is better at 24-27°C. Higher temperatures are beneficial during ripening.

Soil

Watermelon grows best and gives early yield in a well drained sandy loam soil. Alluvial river beds are good for its cultivation. Heavier soils do not permit easy root growth and hence only short duration varieties with smaller fruits are suitable. A soil pH of 6.5-7 is ideal.

Varieties

Sugar Baby: It is a mid season variety. Fruit weight is 3-4 kg with dark green strips. The flesh is deep red very small and matures in 95-100 days. It gives an average yield of 150-170 q/ha.

Asahi Yamato: It is mid season variety. The vines are medium with deeply cut lobed leaves. Fruits medium in size, 6-7 kg, round, pale green, smooth, non striped skin, flesh is deep red in colour, sweet, matures in 95-100 days. Average yield is 200 q/ha.

Sowing time

- Sub-tropical Mid January
- Intermediate low & high March- April

Seed rate: 3.25 kg/ha

Spacing: 2-25m x 60-75cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25-30	60 (120.0)	40 (88.0)	40 (68.0)

Whole of farm yard manure, phosphorus and potassium and 1/2 of nitrogen should be given as basal dose and rest nitrogen should be top dressed in two split doses at the time of vining (20-30 DAS) and at blooming (45-50 DAS).

Irrigation

Water melon responds very much to irrigation but it cannot with stand water logged conditions. Soil moisture stress during pre flowering, flowering and fruit development stages drastically reduces the yield. The crop should be irrigated at 10-15 days interval during summers. Irrigation should be stopped during ripening as it adversely affects the fruit quality and promotes fruit cracking.

Interculture operation

Water melon do not require much attention on inter culture. In early stages the beds and ridges should be kept weed free. Inter culture operation need to be started 15-20 days ays after

sowing. In general 2-3 weedings are required. Pre emergence application of butachlor @ 2.0 kg *a.i*/ha and Trifluralin @ 1-2 Kg *a.i.*/ha are effective.

Maturity Index

The fruit maturity can be determined as below:

- A ripened melon gives dead flat sound when thumped with finger however an immature fruit gives ringing sound.
- The colour of the belly touching the ground usually changes from white to yellow on approaching maturity.
- The tendrils attached to the vine towards fruit dries up.

Harvesting and storage

Water melon should be harvested at proper stage of maturity. The crop is ready for harvesting in 90-120 days after sowing depending up on the cultivar and the season. The fruit should be separated from the vine with the help of knife. Water melons keep well for 1-3 weeks at 2.2-4°C and 80% relative humidity

Average Yield: 170-200 q/ha

Hybrid Water Melon Cultivation

Arka Jyoti: This hybrid has been developed by IIHR Bangalore. Fruits are round to oval, dark green with blue angular stripes, average weight of 5-6 kg; flesh is bright crimson, granular texture wit 12-13% TSS; good keeping and transport quality; first picking starts at about 90 days after sowing; gives yield of 60-80 t/ha.

NS-2895: This hybrid has been developed by Namdhari Seeds, Bangalore. Fruits are blocky, oblong average weight of 7-8 kg having light green rind with dark green stripes. Flesh is deep crimson with good granular texture and high TSS (12-13%); good transport and keeping qualities; gives an average yield of 800q/ha.

4.4 Round Gourd/Indian Squash (Tinda) (*Citrullus vulgaris var. fistullosus*)

Climate

Round gourd requires a warm weather, good sunshine, cloudless days and frost free area. It can be grown at a temperature between 25-30°C. It has relatively shorter growing season than the watermelon.

Soil

It grows best and gives early yield in well drained loamy soils and properly drained heavy soils.

Varieties

Arka Tinda: It is an early season cultivar; the fruits are round, with light green skin, and soft hairs. The crop yields 8-10 picking and Average yield is 100q/ ha.

Tinda 48: Its vines are 75-100 cm long leaves are light green and deeply lobed, fruits are medium sized with average weight of 50 g each. Flesh is white. Average yield is 60-65 q/ha.

Sowing time

Sub tropical Zone

Spring-Summer Crop	Mid January-February
Intermediate Low & High	March- April

Seed rate: 5.0 kg/ha

Spacing: 1.5 m x 45 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	60 (120.0)	30 (66.0)	30 (51.0)

Apply whole of FYM, P_2O_5 and K_2O along with 1/2 N at the time of sowing. Reaming half dose of N may be applied 30 days after sowing.

Interculture operation

Round gourd do not require much attention on inter culture. In early stages the beds and ridges should be kept weed free. Inter culture operation need to be started 15-20 days after sowing. In general 2-3 weedings are required.

Irrigation

The seeds are sown on the pre irrigated furrows on the top of the ridge on both sides of the bed. Subsequent irrigation is applied on the second or third day after sowing. During summer season irrigate the field after 4-5 days interval.

Harvesting

Fruits are ready for first picking after 60 days of sowing. First fruits should be picked up as early as possible so as to facilitate further fruit setting. The other picking should be done when the fruits are medium in size and tender. Picking is done at 3-4 days interval.

4.5 Bottle gourd (*Lagenaria siceraria*)

Climate

Bottle gourd is a summer and rainy season crop. It can withstand cold climate but not the frost. Optimum temperature range for growth and development is 24°-27°C. A soil temperature of 18-22°C promotes good growth and ensures better yield. Short days, comparatively low night temperature and high relative humidity increase the intensity of pistillate flowers in the vine.

Soil

It can be grown in all type of soils. But best growth occurs in soil having pH range of 6-7. Soil moisture is important for rapid growth and it should be at least 10-15% above the permanent wilting point.

Varieties

Pusa Summer Prolific Long: The fruits are long (40-S0cm) with medium girth (20-25cm). The skin colour is yellowish green. This variety is suitable for spring and summer seasons. Average Yield is 200-2S0 q/ha.

Punjab Long: Tolerant to CMV, vines vigorous, profusely branched, first picking starts 70-80 days after sowing, average yield is 400 q/ha.

Punjab Komal: Tolerant to CMV, early maturing, fruits light green, first picking starts 70 days after sowing, average yield is 500 q/ ha.

Pusa Summer Prolific Round: The fruits are green, round and 15-18 cm in girth. It is also suitable for summer and spring planting. Average yield is 200-250 q/ha.

Punjab Round: The fruits are round and smaller in size and are born on the side branches. This variety responds well to fertilization. Average Yield is 175-200 q/ha.

Pant Loki 4: This is a medium duration and high yielding variety of bottle gourd. Fruits are green in colour with light stripes, having hairs, 40 cm long. Yield potential is 300 q/ha.

Sowing time

- Sub tropical: Mid Feb, June-July
- Intermediate (low): March
- Intermediate (High): April - May

Seed rate: 5 Kg/ ha

Spacing: 2-2.5 x 75-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	100 (200.0)	50 (110.0)	50 (85.0)

Full dose of FYM, P_2O_5, K_2O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bottle gourd is comparatively shallow rooted crops hence responds well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation.

Irrigation

During summer season the crop should be irrigated at 3-4 days intervals but in rainy season one irrigation per week is sufficient, depending upon the occurrence of rain. The crop must be irrigated during the critical stages i.e., flowering and fruit setting. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the vine.

Interculture

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting. It should continue till the vines interfere with the normal field operations. Pre emergence application of Linuron @ 0.5 kg/ha, alachlor @ 2.5 kg/ha or Diuron @ 1.25 kg/ha effectively check the weed population in the field.

Harvesting stage

- Proper stages of harvesting can be judged from.

- Fruit size.
- If the gentle press of finger penetrates the epidermis.
- Plugging the fruit which shows fine tender flesh and quite immature seed.
- Presence of hairs on the fruit.

Harvesting and storage

The fruits generally take 12-15 days after fruit set to reach the marketable stage when the fruits are tender. These are harvested with knife by cutting the peduncle. Under normal cool and shady conditions fruits can be kept for 3-5 days. In cold storage conditions the fruits can be stored for 2-3 weeks at a temperature of 8-10°C.

Hybrid Bottle Gourd Cultivation

Pusa Hybrid-1: This hybrid has been developed by IARI, New Delhi. Fruits are medium thick and long, glossy green, suitable for picking and dehydration. First picking starts on 55-60 days after sowing; suitable for growing in spring summer season; gives an average yield of20 t/ha.

Warad (MGH-4): This hybrid has been developed at Mahyco Vegetable Seeds Ltd., Jalna. Fruits are cylindrical, bright green, tender, 40-45 cm long with very soft flesh and weight of about 600-750 g; first picking starts on 60-65 days after sowing; good keeping quality; gives yield of 60- 65 t/ha.

Pusa Hybrid-3: This hybrid has been developed from IARI, New Delhi. Fruits are green, slightly club shaped without neck with good keeping quality. First picking starts on 50-55 days after sowing; gives an average yield of 42.5 t/ha in summer and 47 t/ha in rainy season; suitable for both summer and rainy season cultivation.

Seed rate: 2.5-3.0 kg/ha

Spacing: 2-2.5 m x 60-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (420.0)	100 (220.0)	100 (170.0)

Apply 1/4 N along with full dose of other fertilizers as basal application and the remaining N should be top dressed in three split doses at the time of vining (25-30 DAS), at full bloom (50-55 DAS) and after first harvest (85-90 DAS).

Yield: 425 q/ha (Summer season) 470 q/ha (Kharif season)

4.6. Bitter gourd (*Momordica charantia*)

Climate

It is a warm season crop and can withstand cold better than the other cucurbits, but it is quite susceptible to extreme frost. Bitter gourd thrives best in warm humid regions. Temperature 18°C causes poor germination of seeds, stunting of growth resulting in poor yield. Optimum temperature range for seed germination and growth and development is 25-30°C. Temperature above 36°C causes poor development of pistillate flowers leading to poor yield. Long days and high temperature increases the number of staminate flowers and reduces the number of pistillate flowers.

Soil

The crop can be raised in almost all types of soils but sandy loam and silt loam soils are most preferred. Proper drainage of soil is quite essential. A pH range of 6.5-7 is ideal.

Varieties

Pusa Domausmi: The fruits are long 7-8 cm and green in colour.It is quite suitable for both summer and rainy season. It is prolific bearer and average yield is 100-130 q/ha.

Punjab-14: Suitable for rainy and summer season, plant bushy and bear light green fruits weighing 35g, average yield 140 q/ha.

Pusa Vishesh: Fruits are glossy green, thick, long in size, average fruit weight 120g first picking starts 55-60 days after sowing, gives an average yield of 150 q/ha.

Kalyanpur Baramasi: Plants are vigorous, fruits are long (30-50cm), light green, thin, tapering, gives an average yield of 200 q/ha in about 120 days of crop duration, tolerant to fruit fly and mosaic, suitable for Kharif season.

Sowing time

Sub Tropical	Mid Feb, June-July
Intermediate (low)	March
Intermediate (High)	April-May

Seed rate: 5 kg/ha

Spacing: 1.5-2 m x 75-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	100 (200.0)	50 (110.0)	50 (85.0)

Full dose of FYM, P_2O_5, K_2O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bitter gourd is comparatively shallow rooted crops hence responds well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation

Irrigation

It is shallow rooted crops and roots are mostly concentrated at the top 60 cm soil layer. First irrigation is given immediately after sowing. Critical stages of irrigation are flower bud development and early fruit development when irrigation is necessary. During summer, the crop should be irrigated at 3-4 days interval but in rainy season one irrigation per week is sufficient

Interculture operation

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting.

Harvesting and storage

The marketable fruits are bright green in colour during immature stage and with the passage

of time the green colour fades to a slight whitish yellow or whitish green. First picking starts 65-70 days after sowing depending upon the variety, sowing time, soil type and management practices. Regular harvesting at shorter intervals increases the number of fruits in the vine and irregular harvesting may delay the successive fruit production. The harvested fruits cannot be kept for longer time in ambient conditions so needs to be sent to market as soon as possible. Sprinkle water over the fruits to maintain the freshness for sometime at initial stages. The fruits can be kept in poly propylene bags for extending the shelf life. The fruits can be stored in cold storage at 0.6-1.7°C and 85-90% relative humidity for four weeks.

Hybrid Bitter Gourd Cultivation

Pusa Hybrid 1: Fruits are medium thick & long, suitable for picking and dehydration. First picking starts 55-60 days after sowing, suitable for spring summer season; gives an average yield of 200 q/ha.

Seed rate: 2.5-3.0 kg/ha

Spacing: 1.5-2.0 m x 60-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (420.0)	100 (220.0)	100 (170.0)

Apply 1/4 N along with full dose of other fertilizers as basal application and the remaining N should be top dressed in three split doses at the time of vining (25-30 DAS), at full bloom (50-55 DAS) and after first harvest (60-75 DAS).

Yield: 200 q/ha.

4.7 Pumpkins and squashes

Cucurbita moschata (Pumpkin), *Cucurbita maxima* (Winter squash) *Cucurbita mixta* (Winter squash), *Cucurbita pepo* L. (Summer squash)

Pumpkin (*Cucurbita moschata*)

Climate

Pumpkin requires much longer growing season which is about 80 -100 days. It grows best at an optimum temperature of 20°C-25°C with minimum of 18°C and maximum of 30°C. The crop requires warm, frost free period of 120-140 days and can also withstand the cold. High temperature and long days help to increase the number of staminate flowers and reduce the number of pistillate flowers.

Soil

Deep well drained loamy soils with pH range 6.0-7.0 are ideal for its cultivation. Ideal range of soil temperature for seed germination is 20°C-25°C. Seed germination is hampered at a soil temperature below 10°C and above 30°C. Soil moisture should be at least 10-15% above the permanent wilting point for proper growth & yield.

Varieties

Pusa Vishwas: Fruits are brown and spherical shaped weighing about 4 -5 Kg with thick and golden yellow flesh. Matures in 120 days. Average Yield is 400- 425 q/ha.

Azad Pumpkin-1: Fruits are green with medium broken white pattern and spherical shape. Average Yield is 450- 500 q/ha.

Arka Suryamukhi: The fruits are small, round with flat ends and rind colours deep orange yellow. It has excellent flavour, firm texture and bright orange flesh colour. Average yield is 300-340q/ha.

Arka Chandan: The fruits are round, medium sized and rind colour is light brown. It has excellent flavor, firm texture and bright orange flesh colour. Average fruit weight is 2-3 kg. Average yield is 330 q/ha.

Sowing time

- Sub Tropical: Feb - Mid., March
  June-July (Dry Land)
- Intermediate (low): March
- Intermediate (High): April - May

Seed rate: 5 Kg/ ha

Spacing: 2-2.5 x 75-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	100 (200.0)	50 (110.0)	25 (43.0)

Full dose of FYM, P_2O_5, K_2O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (55-60 DAS). High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation.

Irrigation

The crop must be irrigated during the critical stages *i.e.* flowering and fruit setting stages. In summer season irrigation can be applied at an interval of 5-6 days and in rainy season one irrigation per week is sufficient. Excessive irrigation at fruit maturity stage adversely affects the storage of fruits.

Interculture

Frequent hoeing and weeding of young vines promote healthy growth and heavy fruits. Pre-emergence application of Alachlor @ 2.5 kg a.i /ha checks weed population.

Harvesting and Storage

At full maturity rind colour of the fruits turn brown or reddish brown from green and peduncle either dries up or separates from the fruits. It matures in 160-220 days after sowing depending upon the variety and season of cultivation. Fruits can be kept for 2-4 months without any damage at room temperature however, the fruits should not be kept in heaps. The fruits can be kept for 6 months at 10-12°C temperature with 70-75% relative humidity conditions.

4.8 Gourds

- **Sponge gourd:** (*Luffa cylindrica*) (Ghiya/Tori)
- **Ridge gourd:** (*Luffa acutangula*) (Kali Tori)

Climate

Both these gourds are warm season crops but can also withstand the cold. The fruits of sponge gourd are smooth and the fruits of ridge gourd possess sharp ridges. These grow best at a temperature of 25-30°C.

Soil

Well drained loamy soil with good amount of organic matter is preferred. Soil having pH of 6-7.5 is ideal.

Varieties Sponge gourd

Pusa Chikni: It is an early variety and flowers in about 45 days both in spring and summer. Averge yield is 100-120 q/ha

Pusa Supriya: Fruits are pale green, non-hairy, suitable for spring, summer and rainy seasons; first picking on 50-53 days during summer and 45 days during rainy season gives an average yield of 140q/ha.

Ridge gourd

Pusa Nasadar: It is an medium early variety and flowers in about 65 days both in spring and summer. The fruits are ridged and light green, the flesh is yellow with firm texture and good flavour. Average yield is 100-110 q/ha.

Swarna Manjari: Fruits are highly ridged, green and soft, pulps contain less fibre, tolerant to powdery mildew; first picking starts on 65-70 days after sowing; gives an average yield of 18-20 t/ha in 140-150 days of crop duration.

Swarn Uphar: Fruits are medium sized (200g) weak ridge with soft pulp and less fibre, first picking starts on 65-70 days sowing; gives yield of 200-300q/ ha in 140-150 days of crop duration.

Pant Tori-I: Vines are 5m long bearing 5cm long & club shaped fruits, first picking on 65 days after sowing; average yield 100q/ha; more suitable for rainy season cultivation.

Sowing time

- Sub Tropical: Feb - Mid., March
June-July (Dry Land)
- Intermediate (low): March
- Intermediate (High): April - May

Seed rate: 5 Kg/ ha

Spacing: 1.5-2.5 x 75-90 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	40 (70.0)	30 (66.0)	30 (51.0)

Apply full dose of FYM along with, P_2O_5, K_2O and ½ N at the time of sowing and remaining N should be applied in 2 split doses at 30 and 60 days after planting.

Interculture operation

Hand weeding should be done 15-20 days after sowing second weeding may be done 25-30 days after the first. Spray glysphosate @ 4.5 kg ai/ha applied after weed emergence effectively control the weeds.

Harvesting and storage

The crops should be harvested when the fruits are still immature and after harvesting fruits should be kept at cool places. Gourds are of highly perishable nature and cannot be transferred to distant markets under ordinary packing. Fruit harvested at the marketable stage can stand 3-4 days in a cool place without any adverse effects. The fruits can be stored for 1-2 weeks at 7-10°C with 90-95% relative humidity.

4.8.1 Insect pest management in cucurbits

Red Pumpkin bettle	Spraying of Carbaryl 50WP @ 2 g/lit of water at evening hours or acetamiprid @ 0.3 ml/ lit of water
Jassids and Aphids	Spray dimethoate 30 EC @ 2 ml or metasystox @ 1.0 ml/lit or Malathion 50 EC @ 2 ml or imidacloprid @ 0.3 ml/ lit of water at 15 days interval
Fruit flies (Bactrocera cucurbitae and others Bactrocera spp.)	1. Installation of methyl eugenol traps @ 5-10 per ha or increase its number as required. 2. Spray Malathion @1ml + 10g gur/litre of water at evening hours when fruit flies are congregated on leaf surface

4.8.2 Disease Management in cucurbits

Powdery mildew: *(Sphaerotheca fuliginea and Erysiphe cichoracerzrum)*	
Disease can be identified by appearance of small white patches on the leaves which later on spread to cover whole plant with white floury mass on stem, tendril and even fruits resulting into low yield and poor quality and sun burnt fruits.	1. Spray dinocap @0.05% (50 ml in 100 L of water) carbendazim (100g/100L. water) or wettable sulphur @ 0.2% can also in morning and evening to avoid sulphur injury. Repeat the spray at 7-10 days interval if disease incidence is high
Downy mildew (*Pseudoperonospora cubensis*)	
The disease is more destructive on muskmelon and cucumber during April- May in the irrigated plain and river bed areas. The disease is recognized by presence of yellow spots on upper surface of leaves and purple to brown on the corresponding lower	1. On the appearance of disease spray the crop with mancozeb or zineb@ 0.25% (250g/100 L), copper fungicide 0.3% (300g/100 L) or matalaxyl + mancozeb 0.20% (200g/100 L) Repeat at weekly interval keeping in view the wet weather condition. Thorough spraying is needed in ensuring coverage of the under surface of leaves as well. Collect seed from diseased free fruit.

sides with white downy growth. Leaves wither off prematurely resulting into low, poor quality and sun-burnt fruits.	
Anthracnose (*Collectotrichum lagenarium*)	
It causes dark brown lesions on leaves, fruit stem and fruit in some cucurbits like bottle gourd and melons.	1. Avoid contact of fruit with soil. 2. Don't delay harvesting of first ripened fruit 3. Irrigation may be given in trenches around the root zone only
Fruit rot (*Pythium* sp., *Fusarium* sp., *Phytophthora* sp. or *Rhizoctonia*): Fruits in contact with wet soil develop soft rot.	1. Clean Cultivation 2. Early sowing of the crop 3. At the time of last ploughing mix Carbaryl 15% dust @ 37.5 kg/ha 4. Dust the crop with ash during March-April. Addition of Little quantity of Kerosene oil in the ash improves its repellent quality

5. Rhizome Vegetables

5.1 Colocasia (*Colocasia esculenta*)

Colocasia (Arvi or ghuiyan) is a popular vegetable crop. Almost all the parts of this plant (tubers, leaves and petioles) are used as vegetable. Good chips are prepared from the tubers. Colocasia tubers are rich in starch content. The protein content is about double and sugar content is about half than the potato. It is a good source of vitamins A &B and also calcium and phosphorus. Its leaves are favourite among the leafy vegetables in northern India. "Patir or Paatra" is prepared from tender leaves by rolling and frying in oil after dipping in a paste of gram flour. The tubers are considered as pure food and are eaten during the fast days in northern India.

Climate

It is primarily a warm season crop and can be grown in both summer and rainy season. However, too hot and dry weather adversely affect its growth.

Soil: Colocasia can be grown in almost all types of soil except the clayey soils. However, well drained sandy loam soils are ideal. The field should be prepared well by one deep ploughing and harrowing. Planking should be done to make the soil friable and to conserve the moisture.

Varieties

Satmukhi: It matures in 175-190 days and is a common variety of south India. Average yield is 100-150 q/ha. Other important varieties are: Kovur, Sar kachu, No.40, S-3, S-11, Bangali banda, Faizabadi and Bansi.

Planting Time

It varies from region to region**.** In northern India, the planting is done in February- March (Summer Crop) and June-July (Rainy season Crop).

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
10-15	100 (205.0)	70 (154.0)	90 (153.0)

Whole of FYM, Phosphorus and Potash along with ¾ of nitrogen should be applied at the time of planting. Remaining ¼ dose of nitrogen should be applied as top dressing at the time of earthing up.

Seed rate and Spacing

About 8-12 q/ha sprouted corms/cormlets are required. These are planted in rows 30-45 cm. Apart with row to row spacing of 45-60 cm and 6-8 cm deep. Planting should be done either in flat beds or ridges. While planting, care should be taken that planting depth should not exceed 8 cm. Otherwise germination will suffer.

Irrigation

At the time of planting sufficient moisture is needed. If the moisture is insufficient, than a pre-planting irrigation should be given. The crop grown during summer season should be irrigated at least once in a week. Whereas in rainy season, if the rains are fairly distributed there is no need of any irrigation. In areas where green leaves are used as vegetable, the duration can be increased by irrigation and cutting of leaves regularly. Irrigation during rainy season is needed only when there is long dry spell. Irrigation after the monsoon season may be given at 10-12 days interval. This is only applicable where leaves are taken. If the crop is raised for tubers/corms, no irrigation is needed after monsoon because at that time tubers harden, and foliage dries up.

Weeding and Hoeing

Being a tuberous crop, colocasia needs shallow hoeing for development of corms and cormlets and for checking the growth of *Cyprus rotundus* (Dila/Motha). Generally two hoeing followed by earthing ups would be sufficient. At the time of earthing, additional shoots should be pruned off, leaving one or two main shoots in order to increase more number of cormels. Top dressing of nitrogen should be done at this stage.

Harvesting

It is common practice to take out some side cormels twice or so before the final harvesting; it is known as side harvesting or partial harvesting. This practice gives good remuneration to the growers during colocasia shortage period besides increasing the growth and bulking of central corms. The final harvesting is done 120-150 days after planting when the foliage becomes yellow and dries.

In areas where leaves are cooked as vegetable, the tubers are kept as propagating material for next crop. The leaves become ready for harvesting 45-60 days after planting.

In the first harvesting the yield is low but subsequently the leaf yield increases with each plucking.

Storage

The colocasia tubers can be stored for longer periods even under ordinary conditions. After harvest, the tubers are spread under shade so that the soil adhered gets separated while turning, all the defective, injured, cut or bruised tubers are separated. Only the healthy tubers are graded and stored for market supply and next year planting.

5.1.1 Insect-pest management of colocasia

1. **Flea beetle (*Monolepta signata* Oliver) or white spotted flea beetle:** This is polyphagous in habit. The vegetable crops like beet root, cabbage, cauliflower, chillies and radish act as host plants. The beetles feed on leaves and make holes resulting in slow growth of the plants and ultimately affecting both the leaf and the tuber yields.

   Control measures: Spray the crop with Acetamilaprid @ 0.3ml/l or 5 per cent Carbaryl.

2. **Leaf eating caterpillars:** Larve or a number of lepidopterous pests feed on young leaves which become unfit for human consumption. The common species which damage the colocasia crop are *Pericallia ricini* Fabr., *Agrius convolvuli* L., *Theretra* spp.

   Control measure

   1. Hand-picking of the caterpillars and destroying them.
   2. Spray the crop with Acetamilaprid @ 0.3ml/l.

5.1.2 Diseases management of colocasia

Colocasia blight (*Phytophthora colocasiae* Racib): The disease first appears in the form of small, dark and roundish spots on the leaves and petioles. Later, these increase in size becoming circular, oval or irregular. The corms and cormels may also get damaged.

Control measures

1. Planting of healthy corms and cormels.
2. Spraying of Blitox-50 (0.3%) or Zineb (0.2%) or Bordeaux mixture (1%) with sticker like Sandovit or Teepol or Triton-AE at 0.2 to 0.4 per cent.
3. Grow resistant varieties.
4. Avoiding cultivation of colocasia more than once in the same field.

5.2 Turmeric (*Curcuma longa*)

Turmeric is widely used as a food colorant and is one of the principal ingredient in curry powder. It has long been used in both ayurvedic and Chinese medicine as an anti-inflammatory, to treat digestive disorders and liver problems and for the treatment of skin diseases and wound healing. The active ingredient in turmeric is curcumin.

Climate

The crop can be successfully grown from sea level to an altitude of 1200 m. above mean sea level. It can tolerate an annual rainfall of 640 to 4290 mm. Moderate rainfalls of 1500mm. at sowing, fairly heavy and well distributed rain during growing period and dry weather about one month before harvest are much suitable. The temperature range of 18.2-27.4°C is optimum. The crop is raised as rain fed where rainfall is high and distributed for 5-7 months and as irrigated crop where rainfall is low.

Soil

Turmeric can be grown on various soils but thrives best in well drained, friable, rich sandy or clay soils having a pH range of 4.3-7.5. The crop cannot withstand water logging and alkalinity. Loamy soils are best suited for the development of rhizomes. The soils should be free from stones or gravels.

Varieties

Suroma: Round and plumpy rhizomes, field tolerance to leaf blotch, leaf spot and rhizome scales, duration is 253 days, curcumin: 6.1%, Fresh average yield is 200q/ha and dry recovery is 26.0%.

Ranga: Bold and spindle shaped mother rhizome, suitable for late planting and low lying areas, moderately resistant to leaf blotch and scales, duration is 250 days, curcumin: 6.1%, fresh average yield is 290q/ha and dry recovery is 24.8%.

Rasmi: Bold rhizomes, suitable for both rainfed and irrigated conditions, early and late sown season, duration is 240 days, curcumin:6.4%, Fresh average yield is 313q/ha and dry recovery is 23.0%.

Pant Peethabh: Long attractive fingers, curcumin: 7.5%, Fresh average yield is 200q/ha and dry recovery is 18.5%.

IISR Prabha: High yielding variety, duration is 205 days, curcumin: 6.5%, Fresh average yield is 374.7q/ha and dry recovery is 19.5%.

IISR Prathibha: High quality line, duration is 225 days, curcumin:6.2%, Fresh average yield is 391.2 q/ha and dry recovery is 19.0%.

IISR Alleppy Supreme: Tolerant to leaf blotch diseases, duration is 210 days, curcumin:5.55%, Fresh average yield is 354 q/ha and dry recovery is 19.0%.

Planting time

The optimum time of planting is April-May depending upon the availability of irrigation facility. However it can be delayed till fall of first monsoon showers under the rainfed conditions, but yield is reduced under late planting.

Seed rate

Seed rate varies between 20-25q/ha. The seed rhizomes bits of 30g. with 2 to 3eyes are planted. Rhizomes are treated with 0.25% Dithane M-45+ 0.10% Bavistin for 30 minutes before planting. Hot water treatment at 50°C for 30 minutes without affecting germination eradicates all fungi associated with turmeric seed rhizome.

These seed rhizomes are planted in three ways namely raised bed method where each bed is of 1m width, 15 cm. in height and of any convenient length. Ridge and Furrow method is especially useful to protect crop from water logging in rainy season. Flat system can be followed in sandy loam or well pulverized soils.

Spacing

The spacing varies depending on the planting method followed:

- Raised Bed: 30x20 cm
- Ridge/Furrow method: 45x22.5 cm
- Flat system: 50x15cm

The seed rhizomes are placed 10-12 cm deep in the soil. Germination starts in 10-20 days and will be over by 60 days.

Manuring

Farmyard manure @30-40 t/ha is applied by broadcasting and ploughed at the time of preparation of land or as basal dressing by spreading over the beds. $ZnSO_4$ @ 20 kg/ha may be applied at the time of planting and organic manures like oil cakes can also be applied@ 2t/ha and in such case, the dosage of FYM can be reduced. Integrated application of compost@ 2.5t/ha combined with FYM, biofertilizer *(Azospirillum*) and half of recommended dose of NPK is also recommended. Fertilizers @ 60 kg N (120 kg Urea), 30 kg P_2O_5 (66 kg DAP) and 90 kg K_2O (153 kg MOP) per hectare are to be applied in split doses. Whole of phosphorus & potash should be applied as basal dressing. The nitrogen should be given 45 and 90 days after planting.

Mulching

It is an essential operation in turmeric to enhance sprouting, conserves soil moisture, maintains optimum temperature and prevents weeds, evaporation, runoff of soil due to heavy rains. Preferably locally available material like green or dry grass/leaves, paddy straw, cane trash, sarkanda etc. can be used. Generally 20-25 t/ha is recommended. The first mulching is done at the time of planting and is repeated again after 3 months.

Intercropping

Turmeric is a long duration crop and takes 8-9 months. The field remains occupied for longer duration. Other crops are planted to get maximum returns per unit area. It can be grown as inter crop with chillies, colocasia, onion and brinjal. In this way, more income is obtained and risk of loss in case of natural hazards is reduced. It can be rotated with onion, garlic, chillies and other vegetables in irrigated condition.

Irrigation

A good soaking irrigation is given immediately after planting. Thereafter, irrigate at weekly interval. The number of irrigations may be varied with the soil types. 15-20 irrigations are given for clayey soil and about 40 for the sandy loam soils. During the period of rhizome development and maturity, frequent irrigations are necessary.

Earthing- up

The main aim of earthing -up is to make the plant base strong/stable to avoid lodging of the plants in strong winds. Earthing -up is practiced during 40 -50 days after planting (DAP), 90-105 DAP, and if required 120-135 DAP. This helps to form and enlarge rhizomes and also protect rhizome from insects.

Weed management

The initial growth of turmeric is slow and weed management during this period is must. The pre emergence application of Simazine @ 1.5l/ha or Basalin @ 2.0 l/ha applied immediately after planting can effectively control the weeds.

Harvesting

Depending upon the varieties, the crop matures in 8-9 months. Main season of harvesting falls in January to April. Maturity indication is complete yellowing and drying up of plants. Above ground parts are cut close to the ground level. Field is irrigated 3-4 days in advance of harvesting the crop. The crop is harvested by ploughing or digging. Rhizomes are gathered by hand picking and cleaned.

Yield

Mother rhizomes are separated from the fingers before they are cured. Average rhizome yield is 200-225 q/ha.

Storage of seed rhizomes

Turmeric may be stored in cool and dry environment, to keep the material for the next season sowing. Poor storage causes rotting, dehydration and sprouting. Fully mature and disease free rhizomes are stored. Conventionally the storage is done above or below ground. In above ground, mature and healthy rhizomes are heaped over a layer of 5-10 cm. sand under shade of the tree or shed. These are covered with turmeric leaves. Then the heaps are plastered with earth mixed with cow dung. The rhizomes are treated with Diathane M-45@ 0.25%+ Bavistin@ 0.10% solution for 30 min. and shade dried before heaping. Remove rotten rhizomes at the end of storage period. Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves. In below ground storage, pits if size 1x1x1 m or as per requirement are made under shade/shed. The walls of the pit are plastered with cow dung with a layer of sand at the base. Healthy and disease free rhizomes treated in solution of Diathane M-45+ Bavistin are placed loosely. Filling is done up to 10-15 cm. below from the top. This top is covered with dry grass. The pit is closed with help of wooden plank. Plaster the space between the planks with soil or cow dung. Keep a perforated PVC pipe of 2 inches diameter in the centre of the pit for removal of gases. The material can be stored for 3-4 months in this way. The rhizomes can be removed 20-25 days before planting. The seed rhizomes can also be stored in saw dust and sand.

5.3 Ginger (*Zingiber officinale*)

Ginger is one of the world's most important spice crops. Its characteristic pungency, aroma and flavor are due to the presence of oleoresins and volatile oils. Ginger has immense medicinal value. It warms and softens stomach, cures pains, cough and chest disorders. It acts as analgesic, anti-arthritis, anti- helminthic, anti-ulcer and potential anti oxidant.

Climate

Ginger requires tropical, subtropical and humid climate for its commercial production. It is grown successfully at sea level to 1500 m. above mean sea level and optimum elevation is 300-900 m. in hilly areas where the climatic conditions are different than plains in terms of rainfall and temperature. It can be grown both under rain fed and irrigated conditions. A well distributed annual rainfall of 1500-3000mm. during growing season and dry spells before land preparation and harvesting is required for good growth and yield of the crop. The favorable temperature range is 19-28°C, temperature lower than 13°C induces dormancy, higher than 32°C can cause sunburns and poor relative humidity is also unfavourable. The foliage and rhizomes are also destroyed by frost resulting in poor storability. Cold climate during resting period does not affect the crop. It thrives well under partial shade hence can be grown as an inter crop.

Soil

It can be grown in all types of soils but ideal on is sandy loam soil, light, loose, friable, well drained and at least 30 cm. depth. The rhizome growth is better in slightly acidic soils (pH 6.0-6.5) than the neutral soils. Mostly grown as rain fed, though irrigation is useful. However, it is very sensitive to water logging, frost and salinity. It is tolerant to draught and wind.

Varieties

Suprabha: This variety possess 4.4% crude fibre, 8.9% oleoresin and 1.9% essential oil. Duration is 229 days. Fresh mean yield is 166 q/ha and dry recovery is 20.5%.

Suruchi: This variety possess 3.8% crude fibre, 10.0% oleoresin and 2.0% essential oil. Duration is 218 days. Fresh mean yield is 116 q/ha and dry recovery is 23.5%.

Suravi: This variety has 4.0% crude fibre, 10.2% oleoresin and 2.1% essential oil. Duration is 225 days. Fresh mean yield is 175q/ha and dry recovery is 23.5%.

IISR Varda: This variety has 3.3% crude fibre, 6.7% oleoresin and 1.7% essential oil. Duration is 200days. Fresh mean yield is 226 q/ha and dry recovery is 19.5%.

IISR Mahima: This variety possess 3.3% crude fibre, 4.5% oleoresin and 1.7% essential oil. Duration is 200days. Fresh mean yield is 232 q/ha and dry recovery is 23.0%.

IISR Rejatha: This variety has 4.0% crude fibre, 6.2% oleoresin and 2.4% essential oil. Duration is 200 days. Fresh mean yield is 224 q/ha and dry recovery is 19.0%.

Planting time

- Irrigated conditions: Feb-March
- Rain fed areas: April-May
- Mid and high hills: May-June

Land preparation

The land is ploughed 3-4 times to bring the soil to fine tilth. Compost or well rotten FYM should be applied at the time of field preparation and mixed thoroughly. Beds of convenient size about 3.0m length, 1m width and 15 cm height are prepared with channels of 30-45 cm. to avoid stagnation of water. The alignment of the channels should be in such a way that during rainy season these should act as drains for excess water and before and after rainy season as irrigation channels.

Seed rate

The ginger seed is very costly input and involves about 50% of the total cost of production. Seed rate vary with the size or weight of the seed bits and may be 15-20 q/ha. Bit size may be 15-150 g or 3-10 cm in length or with 2-8 eyes. Seed bits of 20-25 g having 2-3 eyes are generally recommended. Before sowing treat the seed with a mixture of Diathane M-45 (0.25%) + Bavistin (0.10%) + Chlorpyriphos (0.2%) for one hour and dry in shade for 24 hrs. as a safeguard against soft rot and to induce early sprouting. Rhizomes for seed are also treated in hot water at 48°C for 20 minutes before planting. Soaking seed rhizomes in water for 24 hours, 10 days prior to planting results in good sprouting.

Spacing

Ginger can be sown on ridges or furrows or flat beds, however flat sowing on raised beds is preferred. Depending on the seed rhizome size and weight, agro-ecological situation etc. the spacing of 20x25 cm is recommended. Seed bits is placed 3-5 cm deep in the soil.

Manures and Fertilizers

Ginger is very exhaustive and long duration crop thus requires considerable amount of manure and fertilizers. The recommended schedule is as follows:

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25-30	75 (150.0)	50 (110.0)	75 (127.0)

The FYM should be applied by broadcasting during land preparation. Full dose of phosphorus and potash along with 1/3 N should be applied as basal dose. Remaining N should be splitted in two equal doses i.e. one month after germination and rest one month after the second split. The beds are to be earthed up after each top dressing with the fertilizers. Application of neem cake @ 2t/ha at the time of planting helps in reducing the incidence of rhizome rot and increases the yield. Overdoses of nitrogen should be avoided as it induces more tenderness leading to proneness to rhizome rot.

Mulching

It is an essential operation in ginger to enhance sprouting, conserves soil moisture, maintains optimum temperature and prevents weeds, evaporation, runoff of soil due to heavy rains. Preferably locally available material like green or dry grass/leaves, paddy straw, cane trash, sarkanda etc. can be used. Generally 20-25 t/ha is recommended. The first mulching is done at the time of planting or just after planting. It is to be repeated at 40 and 90 days after planting, immediately after weeding, hoeing, earthing up and application of fertilizers. Under low shade mulching may be reduced without affecting the yield.

5.3.1 Insect-pest management in ginger and turmeric

Shoot borer (*Conogethes punctiferalis)*	1. Spraying of Carbaryl 50 WP @ 2 g/lit of water or Malathion 50 EC@ 2 ml/lit of water or BT dipel @ 2g/lit of water 2. Applied as soon as the 5% dead hearts are observed
Rhizome scale (*Aspidiella hartii)*	1. Discard the severely infested rhizomes 2. Soaking of rhizomes in quinalphos 25EC @ 1 ml/lit of water prior to storage and sowing

5.3.2 Disease management in ginger and turmeric

Rhizome rot: Caused by *Pythium myriotylum, P. graminicolum* & *P. aphanidermatum*. The pathogen is soil and seed borne in nature.

Symptoms: The disease is characterized by the appearance of water soaked lesions at the base of pseudo stem and yellowing of lower leaves. The root infection is visible as browning and rotting of roots which advances to rhizomes changing its colour from bright orange to different shades of brown. The rhizomes finally becomes soft & rotten. The infected plants show gradual drying up of leaves along the margins and later entire leaf dries.

Management: Rhizome treatment with a combination of mancozeb (0.25%) and quinalphos (0.075%) for 15 minutes is recommended. Soil drenching with metalaxyl+mancozeb (0.2%) or mancozeb (0.25%) at 15-20 day interval twice with the first appearance of symptoms is effective in managing the disease.

Storage rot: Caused by *Macrophomina phaseolina* and *Cladosporium cladosporioides* Other species viz. *Aspergillus, Fusarium, Rhizoctonia and Sclerotium* are also reported to be associated with rot.

Symptoms: It is a serious problem in turmeric. Improper storage as well as heaping harvested rhizomes under sun results in rotting of rhizomes. The rot is caused by a complex of fungus species. Favorable incubation temperature and relative humidity at 60% leads to maximum spoilage. But no rotting occurs at 15°C even when the RH varied from 30-90%. The rot is maximum in September and minimum in May in north Indian conditions.

Management: Storage rot can be controlled by treating the rhizomes with mancozeb@ 0.25%. After seed treatment, the rhizomes should be well air dried before storage.

6. Leguminous Vegetables

Beans are important both from nutrition as well as commercial point of view. There are a number of cultivated species of beans, but the most commonly grown in the region are French beans and Cowpea.

6.1 French bean (*Phaseolus vulgaris* L.)

Climate

French bean is a cool weather crop but can thrive better than cowpea in the higher temperature. The plants drop their blossoms or pods in very hot weather. The best pods are obtained at 15.6°C to 21.1°C temperature.

Soil

It can be grown on all types of soils ranging from low to heavy clays. Sandy and loam soils are preferred for an early crop but heavier soils are good for the mid-season crop. The optimum soil pH is 5.5-6.8. Liming is needed if soil pH is less than 5.5.

Varieties

Contender: It is bushy type with light green, fleshy, thick and slightly curved pods without fibres and green color. It is tolerant to mosaic and powdery mildew Yield: 110-115 q/ha.

Pusa Parvati: Prolific bearer, pods mature in 40-45 days. It is tolerant to mosaic and powdery mildew. Average yield is 100-110 q/ha.

Arka Komal: Plant erect and bushy. Pods are straight, flat, tender and green. It is very good for transport as keeping quality is good. Yield 200-250 q/ha in 65-70 days.

Pusa Himlata: A pole type. Pods medium long, round, straight, light green, seeds white. First picking 60 days after sowing.

Arka Anoop: Plants are bushy, resistant to both bacterial blight and rust. Pods 17-18 cm long, flat and straight. Average yield is 200 q/ha.

Sowing time

Zone	**Sowing time**	**Varieties**
Sub tropical	last week of January	Contender, Arka Komal
	1st fortnight of February	Pusa Parvati
Intermediate (Mid)	March-April	Contender, Arka Komal,
Temperate (High)		Pusa Parvati
1st Crop	March April	Contender, Arka Komal
2nd Crop	May-June	Pusa Parvati
Seed rate	Bush type (85.0 kg/ha)	
	Pole types (45.0 kg/ha)	

The seed rate for the bush variety is 85.0 kg/ha but that of pole types is almost half or less.

Spacing: Bush type 60 x 10cm.
Pole type

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
50	50	100	50

Apply whole of FYM along with N, P_2O_5 and K_2O at the time of field preparation.

Interculture operation

The plots should be kept weed free for proper growth of the plant. Beans are shallow rooted and sensitive to excessive moisture. However, optimum soil moisture should be made available at the time of fruit set and pod development.

Harvesting and storage

The pods are ready for harvest two to three weeks after the first blossom or in about 45 days after sowing. Picking is usually done by hand. Yield 80-100 q/ha in bush type varieties. The pods can be stored for about 15-20 days at 2-4°C with 60-70% relative humidity.

6.2 Cowpea (*Vigna unguiculata*)

Climate

It is warm season crop and cannot withstand cold weather. It can be grown both in spring and in rainy season in plains but cannot tolerate heavy rainfall.

Soil

It can be grown practically on all types of soils.

Varieties

Pusa Phalguni: It is bushy and dwarf variety, best suited for spring (Feb-March) sowing in the northern plains. The pods are dark green, about 12.5 long and appear in two flushes. The pod gets ready in about 60 days and the yield about 50-100 q/ha.

Pusa Barsati: It is early variety suitable for the rainy season. The pods are about 25-27 crn long and appear in 2-3 flushes. The pods get ready in about 45 days and the yield is about 90-95 q /ha.

Pusa Komal (Sel-1552): Plants are bushy and flowers at 45 days after sowing; pods are light green, 25-30 cm long; suitable for both spring summer and rainy season cultivation; resistant to bacterial blight; gives an average yield of 100 q/ha.

Arka Garima (Sel-61-B): Plants are tall, bushy, purple flowers, pods round fleshy and stringless; tolerant to heat and drought; gives an average yield of 180 q/ha in 90 days of crop duration.

Sel-263: Early maturing, plants are dwarf and can be grown in both spring and rainy season, pods are green, tender and medium (20 cm long); resistant to mosaic, golden mosaic viruses; gives average pod yield of 220 q/ha.

Pusa Dofasli: It is a bushy variety, suited for both spring and rainy seasons. The pod is about 10cm long and gives the first picking about a week later than Pusa Phalguni. It gives about 15 picking in two months and produces about 75-80 q/ha.

Sowing time

Zone	Sowing time
Sub-tropical	February-March (Spring season crop)
	June-July (Rainy season crop)
Intermediate (low)	March (Spring season crop)
	June (Rainy season crop)

Spacing: 45-60 cm x 10-15 cm

Seed rate: 20-25 kg/ha (Spring season crop)

12-17 kg/ha (Rainy season crop)

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25-50	50	60	50

Apply whole of FYM along with full dose of N, P_2O_5 and K_2O/ha at the time of field preparation.

Irrigation operation

In spring season crop 5-6 irrigations are required whereas in rainy season crop as per the requirement irrigation must be given.

Interculture operation

For effective control of weeds two hand weedings and hoeing are required. Basalin @ 1.0 kg a.i./ha in 1000 L of water as pre-planting application is effective.

Harvesting

The marketable pods are available from 45 days in case of early varieties and 100 days in late varieties. Harvesting should be done at proper edible state.

6.3 Insect-pest management of leguminous vegetables

Flea beetles (*Phyllotreta* sp.)	1. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours
Jassids	1. Seed treatment with thiamethoxam 70 WS @ 3g/kg seed or Imidacloprid (Gaucho) @ 5g /kg seed before sowing. 2. Use of delta traps or sticky traps @ 10 /ha 3. Foliar spray of imidacloprid (0.3 ml/lit) during the vegetative stage of the crop (before flowering) 4. Sparying of metasystox 25 EC @ 1 ml/lit or rogor 30 EC @ 2 ml/lit or malathione 50 EC @ 2 ml/lit of water after flowering.
Aphids	1. Use Yellow sticky traps @ 10/ha 2. Spray 2 ml of Malathion 50 EC per lit of water or imidacloprid @ 0.3 ml /lit or of water or Methyl demeton 25 EC@ 1 ml/lit or Dimethoate 30 EC @ 1L/ha as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Pod borer (*Maruca testulalis*)	1. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours or malathione @ 2 ml/lit of water at evening hours. All matured fruits should be picked before spraying.
Hairy caterpillers (*Amsacta moorei)*	1. Collection and destruction of 1st and 2nd instar larvae in gregarious phase.

	2. Spray with Quinalphos 25 EC @ 2ml/lit of water or cypermethrin @ 1 ml/lit of water
Alcidodes signatus, commonly known as bean gall weevil and is a serious pest of green bean (*Phaseolus vulgaris* L.), a leguminous vegetable in temperate areas of Jammu like Basantgarh, Baderwah, Bani etc. The adult female after fertilization, bores the tender portions of the host plant with her snout, turns around to lay egg in the hole. Egg hatches into a apodus larva which feeds on the internal tissues of the plant. As a result the site of injury gets swollen to form gall. The infested plant shows stunted growth and its leaves turn yellowish brown.	1. Broadcast Carbofuron 3G @ 1.25 kg per kanal 2. Proper Staking of rajmah plants 3. Two Sprary of carbaryl @ 2 g per litre of water at 15 days interval at evening hours 4. In case of **non-availability of carbaryl in the market**, use any one the followings-Acetamiprid 20 SP @ 0.3 ml/lit of water or Imidacloprid17.8 SL@ 0.3 ml/lit of water or Thiamethoxam 25 WG @ 0.3 ml/lit of water

6.4 Disease management in leguminous vegetables

Anthracnose: (*Colletotrichum* spp.**)**	Use only healthy and disease free seeds
Sunken black spots with reddish yellow margin appear on almost all parts of the plant including pods. In severe cases seed inside the pods are also infected.	Treat seed with thiram@ 3g/kg of seed before sowing. Spray crop with copper oxychloride, mancozeb or zineb @ 0.25% (250g/100 L water) when disease appears on the foliage
Viral Diseases Yellow mosaic transmitted by whitefly (*Bemisia tabacii*) causing mosaic like pattern on leaves	The disease can be managed by spraying insecticides like imidacloprid (0.03%) or thiomethozam (0.03%) supplemented with resistant variety, healthy seed and timely rouging.

7. Nursery Management in Summer Vegetables

A vegetable nursery is a place or an establishment for raising or handling of young vegetable seedlings until they are ready for more permanent planting.

Advantages

- It is possible to provide favourable growth conditions i.e. germination as well as growth
- Better care of younger plants as it is easy to look after nursery in small area against pathogenic infection, pests and weeds.
- Crop grown by nursery raising is quite early and fetch higher price in the market, so economically more profitable.
- There is saving of land and labour as main fields will be occupied by the crops after 1 month. More intensive crop rotations can be followed.
- More time is available for the preparation of main field because nursery is grown separately.
- As vegetable seeds are very expensive particularly hybrids, so we can economize the seed by sowing them in the nursery.

Site Selection

Critical points needed to be considered while selecting nursery area are:

- Area selected should be well drained, and free from water logging
- There should be proper sunlight,
- The nursery should be near the water supply so that irrigation can be easy.
- The area should be well protected from pet and wild animals

Soil

- Raising of vegetable seedlings requires fertile and healthy soil.
- Preferably, the soil for nursery should be loam to sandy loam, loose and friable, rich in organic matter and well drained.
- The soil pH should be close to the neutral i.e. about 7.0.
- It needs a deep cultivation of the nursery land either by soil turning plough or by spade and subsequent 2-3 hoeing with cultivator.
- After that all the clots, stones and weeds from the field should be removed and land should be levelled.
- Mix 2 kg well rotten and fine Farm yard manure/compost or leaf compost or 500 g vermicompost per square meter and mix in the soil. If the soil is heavy mix 2-3 kg sand per square meter so that the seed emergence may not be hampered.

Soil treatment

A. Soil solarization

- Suitable Time Period: May-June as temperature rises up to 45°C at this time.
- Wet the soil with water, or saturate it with water
- Spread white polythene of 200 gauges on the whole nursery area for about 5-6 weeks.
- The margin of the polythene should be covered by wet soil (compressed mud) to check the entry of air.
- After 5-6 weeks remove the polythene sheet
- Prepare the beds for seed sowing.

B Formalin Solution treatment

- This treatment should be done 15-20 days before seed sowing.
- Prepare formalin solution (1.5 to 2%) in one container and drench the soil @ 4-5 litre of water per square meter soil surface to saturate it up to a depth of 15-20 cm.
- Cover the drench area with polythene sheet of 200 gauge.
- Put the wet soil on the margin of the covered polythene sheet so as it does not allow the polythene film blown away by the wind and air from the covered area to out side.
- Removes the cover (polythene) after 15 days.
- Prepare the beds for seed sowing.

C Application of fungicides

- Generally used fungicides: Captan, Thiram which kill the soil borne pathogens.
- Use 5-6 g of any of the fungicides per square meter nursery area.

D Insect Control

- Presence of certain insect pest and their egg or secondary stage insects present in the soil which can infect the seedlings in the later stage.
- To save the seedlings against them, some insecticides are also used as soil treatment. Recommended insecticide is Chlorpyriphos @ 2 ml/ liter of water.
- Depth of 15 to 20 cm in the nursery soil and then prepared the beds for seed sowing.

Nursery technology for protected cultivation

Improved hi-tech methods of nursery raising have been standardized for healthy disease free and off-season vegetable nursery such as

i. Polythene bags
ii. Plug tray nursery production
iii. Portable low plastic tunnels technology

Growing media used for nursery production

I. Coco-peat

Coco peat also known as coir pith, coir fiber pith and coir dust. Coco peat is relatively new growing medium available these days for the hydroponics and soil less culture. Coco coir is being produced as a byproduct of the coconut tree. Coco peat is a proven best alternative to any growing media. Its use as a growing medium out performs any other medium used for growing vegetables, ornamentals and tree plants. Coco coir is 100% environmentally friendly.

II. Perlite

Perlite is a siliceous mineral of volcanic origin. The grades used in alternate media are first crushed and then heated until the evaporation of combined water expands it to a light powdery substance. It is neutral in reaction and provides no nutrients to the mix except for small amounts of sodium and aluminum.

Seedlings production under protection

The raising of cucurbits seedlings in polythene bags and their transplantation give mature fruits 20-25 days earlier than the normal sowing. The polythene bags of 15 x 10 cm size and 100 gauge thickness are punched at the base and are filled with a mixture of soil, sand and well rotten farm yard manure in ratio of 2:1:1. For raising nursery for 1 hectare, 12.5-15 kg of polythene bags are required. The seed should be sown in bags in the last week of December or in the first week of January. The bags should be placed near the wall facing the sun in order to give them maximum solar heat. Two seeds should be sown per bag at a depth of 1.0-1.5 cm. Watering can be done with rose can just after the seed sowing. Transplanting should be done when the seedlings are 25-30 days old and should be completed latest by 1st fortnight of February

At the time of transplanting a cut is given on the side of the bag with a sharp knife and the bag is removed. The seedlings are transplanted along with the earth ball and the irrigation is given immediately. Other benefits of this method is early yield, less seed rate (i.e. 250 g/ha) and minimum attack of red pumpkin beetle as the crop grows 15-20 days early.

Nursery bed preparation

- Nursery bed should be prepared according to the season and crop.

- In the rainy season raised beds are prepared but in the winter and summer season flat beds should be prepared. Similarly onion in the Rabi season requires flat beds. For the uniform and high percentage of germination the soil must be fine and moist enough.
- If the seedlings are to be raised in boxes during unfavourable weather condition, the flower pots, polythene bags, potting plugs, wooden treys, earthen pots etc. may be used. Prepare soil mixture in the ratio of 1:1:1 of soil, sand and well rotten FYM/leaf mould etc. and fill the mixture in these seedlings raising structure. Arrangement should be made to drain excess water from these structures by making a hole in the bottom of all types of pots.

Raised nursery beds

- Length of the bed may be kept 3 to 5 meter; however, width is restricted to 1 meter only which facilitates intercultural operations.
- The beds are raised 15 to 20 cm high from the ground level. A space of 30 - 40 cm is left in between two beds.
- The space between two beds helps in weeding, nursery care against diseases and insect pest and also for draining out the excess rain water from the nursery beds.
- The number of beds depends on the particular crop, season and growing area of crop.
- The beds should be prepared in the east and west direction and line should be made from north to south direction on the beds.

Line Sowing

- Line sowing is the best method of seed sowing in nursery.
- Lines are made 0.5 to 1.0 cm deep parallel to the width at an distance of 5.0 cm from the line and seeds are sown or placed singly at a distance of about 1.0 cm apart.
- Cover the seeds with fine mixture of sand, soil and well rotten and sieved FYM or leaf compost etc. (1:1:1). After the seed covering a light irrigation must be given.

Seed covering material and its treatments

Seed cover

After seed sowing the seed that are sown either by broadcast method or line sowing method required cover for better emergence. Therefore, a mixture of sand: soil: FYM in the ratio of 1:1:1 is prepared, well mixed together and treated with any method of soil treatment as discussed above. It will be better to treat this mixture while treating the nursery soil. Apply 3-4 g thiram or captan per kg mixture if, it is not treated. Care should be taken that every seed is well covered by seed covering material.

Use of mulch

To maintain the soil moisture for seed germination cover the seed bed with a thin layer of mulch of paddy straw or sugar cane trash, or sarkanda or any organic mulch during hot weather and by plastic mulch (plastic sheet) in cool weather. It has following advantages:

- It maintains the soil moisture and temperature for better seed germination.
- It suppresses the weeds.
- Protects from direct sunlight and raindrops.
- Protects against bird damage.

Removal of mulch

Due attention is given to remove the covered mulch from the seed bed. After three days, observe the seed beds daily. As and when the white thread like structure is seen above the ground, remove the mulch carefully to avoid any damage to emerging plumules. Always remove mulch in the evening hours to avoid harmful effect of bright sun on newly emerging seedlings

Use of shading net

After seed germination during the seedling growth, if there is very high temperature (> 30°C) then beds should be covered by 50% or 60% shedding nets of green/green + black coloured, about 60 - 90 cm above ground by the use of suitable support.

Watering

- The nursery beds require light irrigation with the help of rose can till the seeds get germinated.
- Excess rainwater or irrigated water should be drained out from the field as and when it is required otherwise plants may die due to excess of water.
- Watering in the beds depends upon the weather condition. If temperature is high, open irrigation is applied. Need not to irrigate the beds during rainy days.

Thinning

- It is an important operation to remove weak, unhealthy, diseased, insect pests damaged and dense plants from the nursery beds keeping distance of about 0.5 to 1.0 cm from plant to plant.
- The thinning facilitates balance light and air to each and every plant. It also helps in watching the diseased and insect pest attacked plants while moving around the nursery.

Weed control

- Timely weeding in nursery is very important to get healthy seedling. If there are some weeds in the seed bed, remove them manually either by hand or by hand hoe (thin forked Khurpi).
- Pre emergence herbicides can also be sprayed soon after seed sowing to control the weeds. Stomp @ 3 ml/litre of water should be sprayed on the nursery beds after the seed sowing and seed covering with mixture of FYM, soil and sand.

Plant protection

Adaptation of plant protection measures in the nursery against the incidence of insect pest and diseases is very important task to get the healthy seedlings. Damping off seedlings, leaf curl, leaf blight diseases and leaf miner and borer infect the seedling in the nursery. The care for controlling them time to time is essential.

Damping off

- This is very serious disease of nursery.
- Pre-emergence death of seeds is seen.
- In first instance girdling takes place on the stem near base of the stem and seedlings bent down near the ground and die.

- The causal organisms are pythium, phytopthora, rhizoctonia and *Fusarium* fungi.
- Treat the nursery bed either by soil solarization, formalin solution or formalin dust or fungicides like thiram or captan as discussed earlier.
- Treat the seeds as discussed in seed treatment. If the disease appear after the seed emergence drench the nursery beds with 0.1% solution of brassicol or 0.7% captan or thiram after germination. It will be better to remove and burried the affected seedlings from the beds otherwise spread will be more.
- The disease can be controlled to some extent by applying treated sand, soil and FYM mixture up to the level from where the seedlings are falling.

Raising of virus free seedlings

Leaf curl is a white fly transmitted viral disease, infestation starts from seedling stage and continue till harvest of the crop. The disease is specially seen in the tomato and sometime in chilli too and causes great loss of the crop. The leaves of affected plants show curling, mottling, rolling puckering etc. It can be controlled by the following ways:

- Treat the soil of the nursery by carbofuran 3-5 g/sqm.
- Seed treatment with Imidachloprid @ 2.5 g/kg seed
- Cover the seed bed after seed sowing by Agronet making a tunnel like structure.
- Spray the nursery beds 15 days after seed germination at 7 days interval with Metasytox or Monocrotophos @ 1.5 ml/litre of water. Last spray is done 2 days before transplanting.
- Remove the infected plants if any in the field and burried in with soil or burn.

Selection of seedlings for transplanting

After attaining proper growth, seedlings are transplanted in main field. At the time of transplanting, seedling should be:

- Stocky and sturdy
- Should have good root system
- Should be free from any insect pests and diseases.

Hardening of the plants

- Any treatment that makes the tissues firm to withstand unfavourable environment like low temperature, high temperature and hot dry wind.
- Hardening is physiological process. Plants accumulate more carbohydrates reserves and produce additional quiticle on the leaves.
- In this process seedlings are given some artificial shocks at least 7-10 days before uprooting and transplanting. These shocks includes
- Exposure to the full sunlight,
- Removal of all the shedding nets, polythene sheets
- Irrigation is stopped slowly and slowly.

Techniques of hardening

The hardening is done by the following ways.

- By holding the watering to the plant by 4-5 days before transplanting
- Lowering the temperature also retards the growth and adds to the hardening processes.
- By application of 4000 ppm NaCl with irrigation water or by spraying of 2000 ppm of cycocel

Duration and degrees of hardening

- It is very necessary that plants should be hardened according to their kind so that there is an assurance of high percentage of survival and slow growth under the condition to be expected at the time of transplanting.
- Hardening should be gradual to prevent or check the growth.
- Warm season crops like tomato, brinjal and chillies do not favour severe hardening. In Indian condition allowing the soil to become dry for 5-6 days does the hardening.

Effect of hardening

The following effect may be observed by the hardening

- Hardening improves the quality and modifies the nature of colloids in the plant cell enabling them to resist the loss of water.
- Hardening increases the presence of dry matter and regards in the plants but decrease the percentage of freezable water and transpiration per unit area of leaf.
- Decreases the rate of growth in the plants
- Hardened plants can withstand better against unfavorable weather conditions like hot day winds or low temperature

WINTER

8. Cole crops

The group includes cabbage, cauliflower, knolkhol, broccoli, kale, brussels sprout and Chinese cabbage. This is very important group of winter season vegetables. The crops in this group are closely related and belong to the same genus, Brassica, and most of them are of the same species. All cole crops are hardy and thrive best in cool weather except some well adopted early cauliflower varieties.

8.1 Cauliflower (*Brassica oleracea* var. *botrytis*)

It is the most important vegetable crop of the state grown for its white and tender head or curd formed by the shortened flower parts. It is not a rich source of nutrient, however substantial amount of protein, carbohydrates, phosphorus, calcium, iron and ascorbic acid is present. The edible part of cauliflower is curd.

Climate

It thrives best in cool, moist climate. Dry weather and low humidity are not suitable for it. High temperature produces poor quality curds. Temperature below the optimum during growing period delays maturity and undersized small unmarketable curds or buttons may be formed. Dry hot weather may also give rise to small hard curds.

Soil

It can grow on a wide range of soils provided they are rich in nutrients. Light soils are good for early crop while the clay loam soils are well suited for high yields. Ideal pH is 6-7.

Varieties

Early group

Pusa Katki: This variety is suitable for early sowing. Curds are yellowish white and compact.

Pusa Deepali: Early season crop. Plant are medium tall with erect waxy green short leaves, curd compact white and medium in size. Ready for harvest in 100-120 days. Yield about 200 q/ha.

Medium group

Giant Snow Ball: It is a main season variety. Curds are snow white in colour and large sized. Average yield is 250 q/ha.

Pusa Synthetic: Plants erect, frame narrow medium, curds somewhat creamy white to white and compact.

Pant Shubra: This is a mid season variety. This variety is characterized by semi erect outer leaves. Inner leaves partially cover the curds which are compact, slightly conical, non ricey and creamish white in colour. This variety produces marketable curds by December-January. It takes about 120 days to produce marketable curds from nursery sowing. The yield potential of this variety is 250 q/ha.

Pant Gobhi-2: The marketable curd of this variety are available in October in the plains. The curds are yellowish and medium compact. Average yield about 100 q/ha.

Pant Gobhi-3: This is a synthetic variety. This is classified as September maturity group variety.

The curds are creamish white and non ricey. The yield potential of this variety is about 150 q/ha.

Late group

Snow Ball-16: This is a late variety. The plants are of shortened stem. Curds snow white, self blanched, compact and uniform in maturity. Yield 250-300 q/ha.

Pusa Snow Ball-1: Leaves straight, upright, inner leaves tightly cover the curds. Curds are compact, medium in size and snow white in colour. Yield 250-300 q/ha.

Pusa Snow Ball K-1: Self blanched, snow white curds and resistant to black rot under field conditions. Last to mature in Snow Ball group. Yield 250-300 q/ha.

Kt-25: This is a late maturing variety. Leaves are waxy, upright, slight bending towards inner side with puckered margins. Curds are very solid, medium sized white with good keeping quality. Suitable for transplanting from October to early November and can yield edible curd between end of January to end of March, tolerant to *Sclerotinia* rot and black rot diseases, gives yield up to 200-300q/ha.

Pusa Him Jyoti: Plants are erect, leaves bluish green with waxy coating, self blanched, white curd, average curd weight 500-600 g. It matures in 60-65 days from planting to harvesting. This variety is suitable for April to July sowing in the hills above 1000 m height. Average yield is 160q/ha.

Hisar-1: Suitable for mid late season, curds are medium to large and white in colour. Average yield is 250 q/ha.

Sowing time

Zone	**Sowing time**
Sub-tropical	
Early Group	May- June
Medium Group	August
Late Group	Sept-Oct
Intermediate (Lower)	
1st Crop	May
2nd Crop	Aug.-Sept.
Intermediate (Higher)	
	April-May

Spacing

Early group: 60 cm x 30 cm

Mid and late group: 60 cm x 45 cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	120 (250.0)	60 (132.0)	60 (102.0)

Apply 1/2 N along with other fertilizers as basal application and the remaining N should be top dressed after 35 days after transplanting. Mid late and late varieties need comparatively more nutrients than early and mid early varieties

Integrated nutrient management

The judicious application of phosphatic fertilizers increases curd yield and dry matter content. Cauliflower is responsive to sulphur application hence it is better to apply ammonium sulphate as the source of nitrogen. Weekly spray of 1-2% urea 20 days after transplanting gives better growth and increases the yield. Three foliar sprays of 0.3% borax after 20, 35 and 50 days after transplanting is beneficial in increasing the yield.

Irrigation

Cauliflower is a shallow rooted crop and requires proper soil moisture throughout the cropping period. Early crop may need irrigation twice in a week after transplanting and late crop once a week. During the later stage of the early crop and early stage of the mid season crop, irrigation is only given if there is a long gap in the rains. At the time of curd formation, there should be enough moisture in the field. Irrigation is generally required at 10-12 days interval during the cool season. Total water requirement is about 350 mm.

Intercultural operations

Cauliflower being a shallow rooted crop, deep cultivation should be avoided. The crop needs at least 4 weeks weed free period after transplanting to prevent the yield loss. Pre-plant application of Basalin (Fluchloralin) @ 2-2.5 l/ha or Stomp (Pendimethalin) @ 3.3 l/ha in the finally prepared field followed by 1 hand weeding 40-45 days is the best.

Harvesting

At the time of harvesting, the head should be compact but it should not be broken into segments. The plants are cut well below the head so that the stump thus left protects the head from damage during transportation to the market. Harvesting should be done during morning or evening so that the products may remain fresh for the market.

Storage

Large leaves are trimmed away leaving only sufficient jacket leaves to protect the curd during transportation. More number of jacket leaves are kept when the cauliflowers are transported loose in gunny bags. When they are transported in trays the jacket leaves are trimmed leaving a fringe of leaves projecting 2-3 cm above the curds. Tight packing is essential to prevent shifting and bruising. Storage at 0-1.7°C with 85-90% relative humidity can keep cauliflower for 30 days.

Physiological disorders

Browning

It is caused due to boron deficiency. The water soaked lesions first appear in the stem, leaves and on the surface of the curd, which later on turns rusty brown in colour. The browning of curd is sometimes associated with hollow stem symptoms. The affected curds are bitter in taste.

Control measures:

- Correct the soil reaction and salinity
- Soil application of borax @ 10-15 kg/ha.
- Three sprays of 0.25-0.5% borax solution (1-2 kg/ha) along with a sticker 20, 35 and 90 days after transplanting.

Whip tail

It is caused due to molybedenum deficiency and occurs in the soils with the pH below 5.5. The plants become chlorotic and may turn white particularly along the leaf margins and finally become cup shaped and whither. Leaf blade of the older plants does not develop fully, becomes strap like and hence the name whip tail. In extreme cases the growing point is deformed and no marketable curds are formed.

Control measures

- Raising of soil pH to 6.5 by proper liming.
- Soil application of 1.5 kg/ha sodium or ammonium molybedate mixed with fertilizer or irrigation water after transplanting.
- Three sprays of 0.1% ammonium molybedate solution along with sticker 15, 30 and 45 days after transplanting.

Buttoning

This disorder is characterized by the development of small curds or buttons which cannot be developed to full size of the curd. It is caused due to

- Nitrogen deficiency
- Over aged seedlings.
- Out of season planting.
- Exposure of seedlings to poor light conditions.

Control measures

- Plant varieties according to maturity group.
- Provide recommended dose of nutrition.

Blindness

The plants lack terminal buds and curds and only large dark green thick and leathery leaves develop in these plants and is caused due to

- Injury to terminal bud due to mechanical means or insect attack.
- Out of season planting.
- Exposure of seedlings to very low temperature.

Control measures

- Careful handling of the plants against insect pest and diseases.
- Avoid low temperature exposure.

Riceyness

It is marked by velvety or granular appearance on the curd surface and premature initiation of the flower buds and is caused due to

- Exposure to temperature higher or lower than the optimum required for particular variety in curd development stage.
- Temperature fluctuations during curd development
- Poor seed stock.

Control measures

- Plant varieties according to the maturity group.
- Good seed stock and provide favorable weather conditions.

Cauliflower seed production

The seeds of cauliflower other than late group (Snow Ball) can be produced under sub tropical conditions of Jammu. The field selected for seed production should be fertile, loam or clay loam having good drainage. For certified seed production *in situ* method is preferred whereas for breeder seed production the *ex situ* method of seed production is recommended.

Roguing

When the curds are formed, it might be observed that some plants are definitely of inferior quality even some plants don't form curds and directly bolt. Such plants should invariably be removed. Only healthy curds that are true to type and free from diseases be allowed to remain in the field for raising seed. Cauliflower seed is expensive and its quality should be maintained. Blanching habit of the leaves be given special attention while roguing. It may also be kept in mind that replanting of cauliflower curds is not desirable. One more roguing should be done at bolting stage to remove early and extremely late bolters. The loose curds also start bolting from the centre which should be rejected.

Isolation

Seed crop of cauliflower should be isolated by 1600 m distance from other varieties of cauliflower and other cole crops like cabbage, knolkhol, brussel's sprout etc. grown for seed production.

Harvesting and curing

After curd formation the flowering appears and later on pod setting takes place. Care should be taken to see that sufficient insect pollinators are available at the flowering time. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days more.

Seed yield: 350- 400 Kg/ha.

Hybrid Cauliflower Cultivation

Punam: This hybrid is of 95 days maturity group, developed by Beejo Sheetal Seeds Pvt. Ltd., Jalna. Curds are solid with 1.5-2.0 kg of average weight; gives yield of 200-250q/ha. This is popular among the farmers of J&K, HP and Uttaranchal. Seeds could be obtained from the developing centre.

Pusa Hybrid-2: Pusa Hybrid-2 are semi-erect hybrid with bluish- green upright leaves, curds are creamy-white, highly compact, average weight 907g; matures from mid-November to mid-December in the North Indian Plains; resistance to downy mildew; gives an average yield of 250q/ha;

Priya: This hybrid is of mid-early maturity group; developed by Beejo Sheetal Seeds Pvt. Ltd., Jalna. Curds are solid, milky white with 1.0 kg of average weight and protected by dark green outer leaves; gives yield of 200-250q/ha.

Ageti Himlata: This is an early maturing hybrid developed by Century Seeds Pvt. Ltd., New Delhi. Curds are very compact, medium sized, firm, dome shaped with smooth texture, able to retain pure white colour even in hot sun.

NS-60: This popular hybrid with mid season maturity group has been developed by Namdhari Seeds Pvt. Ltd., Bangalore. Curds are attractive, compact, dome shaped, milky white with a

weight of 1.25-1.5 kg and good firmness; gives an average yield of 250q/ha in 60-65 days of crop duration (May-Sept in South India).

NS-66: This hybrid with mid-late season maturity group has been developed by Namdhari Seeds Pvt. Ltd., Bangalore. Curds are attractive, compact, smooth, dome shaped, pure white with an average weight of 1.5-1.7 kg and good firmness; gives an average yield of 250q/ha in 70-75 days of maturity duration (Sept-Oct in North India).

Summer King: Curds dome shaped, creamy white, 400-600 g weight, self blanching, mature in about 55 days after transplanting, suitable for summer season cultivation.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (420.0)	100 (220.0)	100 (170.0)

Apply 1/2 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 20 days interval.

Seed rate: 350-500 g/ha.

Spacing: 60 x 60cm

Varieties Pusa Ageti:

8.2 Cabbage (*Brassica oleracea* var. *capitata*)

Climate

This is a cool season crop and thrives well in a relatively cool & moist climate. It is grown mainly as a winter crop in sub-tropical plains.

Soil

For early crop sandy or sandy loam soils are preferred. For late crop lay loam and silty soils are preferred. Tropical type variety produces seed under subtropical conditions. Produces marketable heads at temperature range of 15-30°C but the day temperature should not be above 35°C. Recommended for March and August-October planting in northern India. Head weight is 600-1200 g, ready for harvest in 75-90 days after transplanting. Yield is 310-330q/ha.

Pusa Drum Head: Heads are large, 3-4 kg, flat, cover leaves are light green, field resistance to black leg disease. Ready to harvest in 80-90 days after transplanting. Yield is 250 q/ha.

Golden Acre: The plant is small, head is round, cover leaves are dark green, cup shaped with prominent veins. Becomes ready in 60-75 days after transplanting. It yields about 225-250 q/ha and gets ready for the market in 60 days.

Pride of India: Head round, solid and medium large sized weighing about 1-1.5 kg, very good for marketing. It yields about 250-300 q/ha.

Pusa Mukta: Bacterial rot resistant variety, plants have short stalk, medium frame and light green wavy puckered leaves. Heads are compact, flattish round with loose wrapper leaf at the top, 1.5-2.0 kg of weight, gives an average yield of 200-300 q/ha.

Sowing time:

Zone	Sowing time
Sub-tropical	Aug.-Sept.
Intermediate (Lower)	July-Aug.
Intermediate (High)	May-June

Seed rate

- Early varieties: 500 g/ha
- Late varieties: 375 g/ha

Spacing

- Early varieties: 45cm x 45cm
- Late varieties: 50cm x 50cm

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	120 (250.0)	60 (132.0)	60 (102.0)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 30 days interval after transplanting.

Integrated nutrient management

The judicious application of phosphatic fertilizers increases curd yield and dry matter content. Cabbage is responsive to sulphur application hence it is better to apply ammonium sulphate as the source of nitrogen. Weekly spray of 1-2% urea 20 days after transplanting gives better growth and increases the yield. Three foliar sprays of 0.3% borax after 20, 35 and 50 days after transplanting is beneficial in increasing the yield.

Irrigation

Cabbage requires a continuous supply of moisture for proper development. It may be irrigated after every 10 days. This interval may be shortened for late varieties and in hot season. It should not be irrigated when the heads are fully developed and quite firm, otherwise many of them will burst or split within 24 hours.

Intercultural operations

Three hoeing are sufficient for cabbage. Earthing-up of plants after 5-6 week is essential to produce solid heads.

Harvesting

Cabbage heads are harvested when they attain full size and are hard. The best time for harvesting is in after noon or early morning. The heads when mature should be cut with a long knife.

Cabbage seed production

The seed production of cabbage is only possible under temperate conditions of Jammu where chilling requirements ranging from 0-4°C for a period of 8-10 week after head formation prevails.

Manures and fertilizers

Before replanting, phosphatic and potassic fertilizers are applied and the nitrogen is applied in split doses, the first one month after replanting, second at the time of bolting and the third just after flowering.

Selection and roguing

The roguing is done in November when the heads formation is normally complete. The off-types and undesirables not confirming to the varietal characteristics are rogued out. The second roguing is done during April before heads start bursting. The loose stems with heavy frames should also be removed.

Over wintering

In areas where winters are not very severe, the heads may be allowed to over winter in the field either in the open field or by covering; it is preferable that these are stored in trenches of 2 x 1x1 meter size, because of the risk of theft of heads. The outer leaves of selected plant are removed and the plants are arranged in single layer and then covered, leaving holes on both sides for aeration. The plants are replanted in the field in March-April before the head start bursting.

Isolation

The seed production fields should be isolated by 1600 m in all directions from other cabbage varieties, cauliflower, knoll-khol, brussels sprouts and kale.

Harvesting and threshing: Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days.

Seed yield: 800-1200 kg/ha

Hybrid Cabbage Cultivation

Sri Ganesh Gole: This hybrid is developed by Mahyco Vegetable Seeds, Jalna. Heads are round, compact, attractive, bluish green; ready for harvest on 90-95 days after transplanting; resistance to yellowing; good transport quality; gives yield of 750-850 q/ha.

Konark: This hybrid is of mid season maturity group, developed by Century Seeds Pvt. Ltd., New Delhi. Heads are compact, flatish round with strong outer leaves and average weight of 2.5-3.0 kg; suitable for fresh market.

Manisha: This is all season hybrid tolerant to fusarium wilt, developed by Clause International, Secunderabad. Heads are compact, round, 1-2 kg of average weight, blue green with good leaf wrap.

Sumit: This is an extra early hybrid developed by Sungro Seeds Ltd., New Delhi. Heads are shining green, very compact, round with average weight of 1.0-1.25 kg and small core.

H-139: This hybrid has been developed at Mahyco Vegetable Seeds, Jalna. Heads are very compact and uniform. Average head weight 1.8 to 2.0 kg.

Quisto: This hybrid has been developed by Syngenta India Seeds Ltd., Pune. Plants are strong, self supporting, sturdy, erect, compact with bluish green, fleshy, broad leaves with serrated collars. Heads are compact, dark green, heavy (1-3 kg), round and tender core with fine internal structure; ready for harvest on 15-80 after transplanting; tolerant to fusarium wilt; gives yield of 600-800q/ha.

Nav Kranti (MHCB-600): This hybrid has been developed by Mahyco Vegetable Seeds Ltd., Jalna, Heads are small, bright green, round, highly compact, 0.8-1.0 kg of average weight; ready for harvest on 60-70 days after transplanting; tolerant to DBM, damping off and black rot gives yield of 500-550 q/ha.

NS-25: This is an early hybrid developed by Namdhari Seeds Pvt. Ltd., Bangalore. Heads are uniform, small, compact, good wrapper bluish green leaves, round, 1.0-1.2 kg of average weight, excellent firmness; suitable for close planting; good for early market and shipping; very slow bursting with good field holding capacity.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	200 (400.0)	100 (220.0)	100 (170.0)

Apply 1/4 N along with other fertilizers as basal application and the remaining N should be top dressed in three split doses at 30 days interval after transplanting.

Spacing: 50cm x 50cm

8.3 Knol-khol (*Brassica oleracea* var. *gongyloides*)

Climate: This is a cool season crop and thrives well in a relatively cool and moist climate. It is grown mainly as a winter crop in sub-tropical plains.

Soil: For early crop sandy or sandy loam soils are preferred. For late crop clay loam and silty soils are preferred.

Varieties

SJKK-01 (G-40): It is an early maturing variety. Marketable knobs matures in 35±5 days. SJKK-01 has globular flat knobs, short stalk length with erect and smooth leaves. The variety is tolerant to Alternaria blight, stalk rot, downey mildew, cabbage butterfly and semi loopers. Yield potential is 300 - 350 q/ha.

White Vienna: An early variety maturing in 70 days, leaves and stems medium dwarf; knob globular, light green and smooth, fleshy creamy white and tender,

Purple Vienna: Matures about a week later. The knobs are purplish and fleshy greenish white.

King of Market: An early variety maturing in 70 days, knob flattened, fleshy, light green with profuse foliage. Leaves are more in number than White Vienna.

Sowing time: Knol-khol can be grown all the year round under sub-tropical zone of Jammu Division.

Zone	**Sowing time**	**Transplanting time**
Subtropical		
1st crop	Mid Sept.	Mid Oct.
2nd crop	Mid Oct.	2nd week of Dec.
3rd crop	Mid Feb.	Last week of March
4th crop	Last week of March	Mid April
5th crop	Last week of August	Direct sowing

Note: Direct sowing of the crop in lines 30 cm apart by kera method can also be done by the end of August. Thin the crop by keeping 20 cm distance between the plant after one month. The plants obtained by thinning can further be transplanted in the field in the month of October.

Spacing: 30cm x 20cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
30	100 (200.0)	50 (110.0)	50 (85.0)

Intercultural operations

Frequent shallow inter culture should be done in the soil to kill the weeds and to provide the soil mulch. Cauliflower being a shallow rooted crop, deep cultivation should be avoided. Weeding should be done as the plants are well set in the field.

Harvesting

The crop may be harvested when the swollen stem is 5-7.5 cm in diameter, soft and non fibrous. For its marketing cut off the main roots and then tie leaves with enlarged stem in bunches.

Knol-khol seed production

The field selected for seed production should be fertile, loam or clay loam having good drainage. For certified seed production *in situ* method is preferred whereas for breeder seed production the *ex situ* method of seed production is recommended.

Roguing

Only healthy knobs, true to type and free from diseases are allowed to remain in the field for raising seed. Another roguing should be done at bolting stage to remove early and extremely late bolters.

Isolation

Seed crop of knol-khol should be isolated by 1600m distance from other varieties of knol-khol and other cole crops like cabbage, knol-khol, brussels sprout etc. grown for seed production.

Harvesting and curing

The flowering appears after 30-35 days of replanting of the selected knobs and there after pod setting takes place. Care should be taken to see that sufficient insect pollinators are available at the flowering time. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days more.

Seed yield: 800-1000 Kg/ha.

8.4 Insect-pest management in cole crops

Cutworm (*Agrotis Spp*.)	1. Deep ploughing of fields before planting 2. Use Chlorpyriphos 1.5%D @ 20kg/ha as soil treatment before sowing 3. Broadcasting of Carbofuron 3G @ 30 kg/ha
Cabbage butterfly (*Pieris brassicae*)	1. Release of *Trichogramma chilonis* @ 50,000 adults /ha per release (6 times) at weekly interval in Mid January 2. Promotion of *Cotesia glomeratus,* potential parasitoids against cabbage butterfly larva can be encouraged by planting border row of mustard and coriander as flowering plants. 3. Foliar spray of *Bacillus thuringiensis dipel* formulations @ 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad @ 0.3 ml/r liter is found promising to control all lepidopteran insect pests in cole crops. 4. Don't spray the crop near harvesting.

Cabbage semilooper (*Plusia orichalcea)*	Spraying of cypermethrin or fenvalerate @ 1 ml/lit of water
Cabbage aphid (*Brevicoryne brassicae*)	Spraying of cypermethrin or fenvalerate @ 1 ml/lit of water
White grubs (*Melolontha furcicuada*)	1. Deep ploughing of fields before planting 2. Use Chlorpyriphos 1.5%D @ 20kg/ha as soil treatment before sowing 3. Broadcasting of Carbofuron 3G @ 30 kg/ha
Mustard Sawfly (*Athalia lugans proxima*)	1. Carbaryl 10% D @ 20kg or Malathion 5% D @ 20kg/ha 2. Spraying of Cypermethrin @ 1 ml/lit of water at evening hours
Stem borer (*Hellula undulalis*)	1. Sparaying of cypermeththrin or fenvalerate @ 1 ml/lit of water when the damage is observed in the late stage
Tobacco caterpillar (*Spodoptera litura*)	1. Installation of spodolure pheromone traps @ 12-15 for mass destruction of adult moths. 2. Spraying of Cypermeththrin @ 1 ml/lit of water at evening hours or Splt NPV @ 1 ml/lit of water at evening hours

8.5 Disease management in cole crops

Black rot (*Xanthomonos compestris pv. compestris.*)

'V' shaped yellow lesions on the edges of the leaves which turns dark brown later on. The veins may show black or brown discolouration. In severe cases, the curd formation may not be proper.

Control measures

- Collect seeds from disease free area / plants.
- Soak seeds in plain tap water for 30 minutes, thereafter, treat the seeds with hot water 50ºC, mixed with Streptocycline 100 ppm (1g/10 liter) for 30 minutes.dry the seeds in shade before sowing.
- Spray the crop with Streptocycline 100 ppm or Copper fungicides (0.3%) particularly the crop meant for seed production in diseased prone area.
- Destroy the diseased debris after harvest.

Damping off (*Phytophthora, Pythium, Rhizocotonia spp.)*

Both pre and post emergence death of seedlings.

Control measures

- Treat nursery beds with Formalin (1 part formalin 7 parts water) 3-4 days before sowing.
- Get healthy seeds.
- Seed treatment as in damping off of tomato.
- Always transplant diseased free seedlings

Downy mildew (*Peronospora parasitica*)

Characteristic water soaked round lesions on under surface of the leaves and also cause curd rot. Rotten tissue become brown and are surrounded with black discolouration at the base of the curd stalk.

Control measures

- Spray the crop[with Metalaxyl + Mancozeb 0.25% at 10-15 days interval starting from just appearance of disease in problematic area.
- **Stalk rot** (*Sclerotinia sclerotirum, Alternaria, Botrytis spp., Erwinia caratovora and baccillius polymixa.)* Leaves droop down, stalk rots from inside becomes hollow and filled with black sclerotia, curds if formed develops white rot.

Control measures

- Follow cauliflower- paddy rotation.
- Uproot diseased plant and destroy. Spray Carbendazin 50 WP (0.05-0.10%) from earthing up stage at 10-15 days interval till bolting in diseased prone areas / field.

9. Root crops

Radish, carrot and turnip are sown direct. They are almost similar in their cultural requirements. All of them are mainly grown for fleshy roots.

9.1 Radish (Raphanus sativus)

Climate

Radish is a cool season crop but the Asiatic varieties can resist heat more than the European varieties. It attains best flavour, texture and size at 10-15°C. During hot weather the roots produced are small and fibrous, later on becomes tough or ill shaped and extremely pungent. High temperature leads to bolting without adequate root formation.

Soil

It may be grown on all kinds of soils. However, best radish is produced on sandy loam soils which are friable and contains high amount of humus. Heavy soils produce rough ill shaped roots with a number of small fibrous and branched roots. Ideal soil pH ranges between 5.5-6.8.

Varieties

Japanese White: It is an Asiatic variety. The roots are 25-30cm long cylindrical in shape with stump end, skin is white and smooth. Flesh is snow white, crisp, solid and mildly pungent. It matures in 65-70 days. Average yield is 150-300 q/ha.

Minowase: The roots are 30-35 cm in length, cylindrical in shape, smooth and white. The tops are medium and less pungent than Japanese White.

Pusa Chetki: A hot season variety suitable for extreme early and late sowing. Roots are medium long, pure white, stumpy and soft in texture. Ready for harvest in 40-45 days.

Pusa Himani: The roots are 30-35cm long, pure white with whitish green shoulder. The roots are mildly pungent with green tops. Roots medium long, white and soft. Good size roots are ready in 50-60days. It is suitable for December-February sowing in plants.

Pusa Reshmi: Root white with green tinge on top of roots are 30-40 cm in length, suitable for early sowing in cooler months. Tolerate slightly higher temperature. Good size roots are ready in 50-60 days.

White Icicle: Plant top is medium short, root pure white, thin, tender and solid. Flesh is icy white, crispy, mildly pungent and flavoured.

Pusa Desi: Roots are white with green shoulders, 30-35 cm long, medium thick, tapering, pungent, leaves dark green. Suitable for sowing from mid Aug.-Sept. in northern plains. It matures in 50-55 days. Average yield is 300 q/ha.

Arka Nishant: Roots are long, marble white in colour, with crisp texture and mild pungency. Resistant to pithiness, premature bolting, root branching and forking.

Average yield is 350-400 q/ha.

Sowing time

Zone	Sowing time	Variety
Sub-tropical	March-May, July-August (Periodical sowing)	Pusa Chetki, Pusa Desi, Pusa Himani
	Sept-October	Pusa Reshmi
	End Nov-Jan	Japanese White, Arka Nishant and Minowase
Intermediate (Low)	Mid Aug.-Nov.	Japanese White and Minowase
Intermediate (High)	March-June	Pusa Himani
	Aug.-Sep.	Pusa Reshmi, Japanese White and Minowase

Seed rate

- 10-12 kg/ha (Asiatic types): Kera Method
- 15-18 kg/ha (European types): Kera Method
- 4-5 Kg/ha (Dibbling Method)

Spacing

- Asiatic types: 30-45 cm x 8-10 cm
- European types: 20-25 cm x 5-6 cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
30	60 (120.0)	30 (66.0)	50 (85.0)

Apply whole of FYM together with P_2O_5 and K_2O and half of N at the time of field preparation. Remaining half N should be applied at the time of earthing up.

Method of sowing

Radish is sown on ridges which are 45cm apart. l.5-2.0 cm deep furrow is drawn on the top of each ridge with a pointed stick. The seed is sown in the furrow with proper moisture by using kera method and then furrow is closed. Before the second irrigation, the plants should be thinned out properly.

Irrigation

Irrigation immediately after sowing is the best to good seed germination and establishment of the crop. Next irrigation should be on the third day and subsequently once in 5-7 days. During summer months frequent irrigation is necessary otherwise the growth will be checked and the root becomes pungent and tough. The total irrigation requirements for radish are found to be about 210-250 mm.

Intercultural operations

Before the second irrigation, the thinning of thickly sown plants should be done to keep them at 2 cm apart (European varieties) and 5-6cm a part (Desi varieties). Weeds are removed and open roots are earthed up twice in the case of Asiatic varieties and only one weeding and earthing up is sufficient in case of European Varieties. Timely thinning is also very important.

Harvesting and storage

There should be sufficient moisture in the soil at the time of pulling out the roots by hand. Tender, crisp and large roots are pulled along with leaves and smaller ones are left on the ridges. This will help to get more yield per unit area as the smaller roots will have better chance to develop. Asiatic varieties can yield 250-300q/ha and the European varieties 60-80q/ha. Roots can be stored for about two months at 0°-1.0°C and 90-95% relative humidity.

Physiological disorders

Hollow root: High temperature during 16-30 days of sowing inhibits the formation of secondary meristem in the center of roots leading to development of intercellular spaces which would otherwise have been filled with parenchyma cells. The environmental conditions and boron deficiency results in hollow root formation.

Wart: It is the physiological disorder which is a white protrusion of white inner root tissue through the splits in the skin mainly occur due to soil moisture deficiency.

Pithiness: It occurs more in the summers than in spring or autumn crop. Excess application of fertilizers, soil moisture stress and high temperature conditions three weeks before harvest results in pithiness.

Control measures:

- Keep proper moisture conditions in the field.
- Avoid growing sensitive varieties during summer season.
- Excess application of the fertilizers should be avoided.
- Spray 0.3% borax 25 and 40 days after sowing.

Radish seed production

The seed of radish varieties Pusa Chetki, Pusa Reshmi, Japanese White and Minowase can be successfully produced under sub-tropical conditions of Jammu. For seed production Pusa Chetki can be sown in August in plains and stecklings can be transplanted in September. Japanese white can be sown in October and stecklings can be transplanted in middle of November. In the first instance, the crop is raised for production of roots. The roots are uprooted, selected and finally planted for seed production. The roots thus produced in one hectare area are sufficient to plant 4-5 hectares of seed crop. One third of root and two-third of foliage is clipped off. The planting of the cut roots may be done on ridges or flat fields immediately at 60 x30cm distance. The crown is kept just above the soil level and field is irrigated immediately. Apply 30kg P_2O_5 and 50kg K_2O at the time of replanting along with 30 tonnes FYM. Use nitrogen (60kg) in three splits i.e. first at the time of replanting, second at bolting and third at flowering. Only true to type, disease free roots should be selected for seed production. If any early or light bolters are observed, these should be removed. Seed crop of radish should be isolated by 1000m distance from other varieties of radish. When the pods are quite ripe, the crop is generally harvested in single lot. The pods are sun dried and threshed. The threshing is comparatively difficult and needs repetition.

Seed yield: 120-150kg/ha.

9.2 Carrot (*Daucus carota*)

Climate

The carrot is a cool season crop though some of the tropical types tolerate quite high temperatures. Seed germinate under a wide temperature range of 7.2-23.9°C. The colour development and growth of the roots are affected by the temperatures. The top growth is optimum at a mean temperature of 16-18°C and the root yield and colour development is more at a temperature range of 20-22°C. Cool night temperature is essential for carrot production in the tropical areas.

Soil

Carrots can be gown on all types of soil. It thrives best on a deep, loose and loamy soil. The pH of 6.7 is ideal and yield is extremely low at low pH.

Varieties

Nantes: It is a European top quality stump root carrot, cylindrical and 13-15cm long with sweet roots. Its skin, flesh and core are orange. Roots are smooth, attractive and get ready in 90-100 days after planting. Suitable for sowing from mid Oct.-early Dec. Average yield is 120 q/ha.

Pusa Kesar: An improved type of Asiatic red carrot with reduced foliage. Roots with self coloured narrow central core. It is rich in carotene (30 mg per l00g of edible portion). It can stay in field for about a month longer than other varieties without bolting. It matures in 80-90 days. Average yield is 300 q/ha.

Chaman: Temperate variety plants dark green and semi-erect foliage; roots long, cylindrical, tolerant to cracking and forking; yield 25-27 t/ha.

Pusa Yamdagini: Temperate variety. Roots are 15-16 cm long, orange with self coloured core, slightly tapered, rich in carotene, gives an average yield of 90-100 q/ha in 90-100 days of crop duration.

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
30	60 (120.0)	30 (66.0)	50 (85.0)

Apply whole of FYM together with P_2O_5, K_2O and half N at the time of field preparation. Remaining half of nitrogen should be applied in two split dose i.e. after the first hoeing and weeding and after 30 days of germination. Excess N application reduces root quality (decrease in sugar, dry matter, beta carotene and vitamin C) and storability.

Sowing time

Zone	Sowing time	Variety
Sub-tropical	Sept.-Oct.	Pusa Kesar,
		Pusa Yamdagini
	Oct.-Nov.	Nantes
Intermediate (Low)	Aug.-Sept.	Pusa Kesar
	Sept.-Oct.	Nantes
		Pusa Yamdagini
Intermediate (High)	April-Aug.	Nantes

Seeds are soaked in water for 12-24 hours prior to sowing to hasten germination.

Seed rate	Asiatic type	6-8 kg/ha
	European type	5-6 kg/ha
Spacing	Asiatic type	30-45 cm x 22-25 cm
	European type	30 cm x 22-25 cm

Intercultural operations

In the early stages carrot grows slowly and normally cannot compete with weeds. Weeding at this stage is very necessary but very little hoeing is needed after the plants are 8-10 cm high. Weeding and hoeing should not be done during dry weather. The exposure of roots to the dry winds causes loss of moisture, arrested growth and damage to the roots. The crown should not be exposed since it causes green discoloration and lowers the quality of the roots. To control the weeds, spray Stomp @ 3.5 l/ha immediately after sowing.

Thinning

When the plants are well established, thin them to 3-4 cm apart to ensure proper development. If the roots are over-crowded, their shape and size are affected adversely. Thinning should be done in moist soil.

Irrigation

The sowing should be done when moisture is sufficient. The first irrigation should be given 5 days after sowing and the second 3-4 days thereafter. The furrows should be kept moist till the seed has germinated. Subsequent irrigations are given before any wilting appears. The crop should be irrigated after a week if the soil is sandy and after 10-14 days, if it is loam. Never irrigate a carrot field heavily as this practice will result in excessive foliage, produce low quality roots and result in late maturity.

Harvesting and storage

Start digging when the roots are 2.5-3.0 cm in diameter at the upper end. Light irrigation is given a few days before harvest. Tops are removed and roots are dug with a spade. The soil may be loosened with a plough to reduce the cost of large scale harvesting. Generally, Asiatic type gives 200-300q/ha and European type 100-150q/ha yield. At temperature of 0.0-4.5°C with 93-98% relative humidity carrots can be stored for 6 months.

Physiological disorders

Splitting or cracking of roots: It is a major problem in many carrot growing areas.

Control measures

- The splitting is reduced by low nitrogen application.

Cavity spot: This disorder appears as a cavity in the cortex, in most cases the subtending epidermis collapses to form a pitted lesions. This is mainly due to deficiency of calcium and increased accumulation of potassium.

Control measures

- Increase in calcium level in the growing medium by liming.

Root forking: Roots get forked in poorly prepared soils having clods. Roots in touch of the lumps of un-decomposed organic matter also get forked.

Control measures

- Land should be prepared finely so that the primary root may grow freely and use well decomposed FYM.

Carrot seed production

The seed of Pusa Kesar variety of carrot can be produced successfully under sub-tropical conditions of Jammu region where as seed of variety Nantes can be produced only in temperate areas. In the first instance the crop is raised for production of roots. Then the roots are uprooted and true to type, healthy roots of 7.5-10.0 cm diameter are selected and replanted at a distance of 60 cm x 60 cm (after clipping two-third of foliage and 1/2 of root.) The roots raised for one hectare are sufficient to plant four hectare seed crop.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
30	60 (120.0)	30 (66.0)	50 (85.0)

FYM, P_2O_5 and K_2O should be applied at the time of replanting and nitrogen in three splits doses at replanting, bolting and flowering.

Isolation

The production field should be isolated by 800m in all directions from any other carrot crop variety.

Roguing

The undesirable plants which are not true to type should be removed from the fields.

Harvesting and threshing

Harvesting of seed crops is generally done three times because seed crops matures unevenly. After harvesting, it should be threshed and cleaned.

Seed yield: 400-500kg/ha.

9.3 Turnip (*Brassica rapa*)

Climate

It is a cool weather crop and thrives best in a cool and moist climate. If sown in hot weather, the root becomes woody, bitter, mishappen and small.

Soil

It may be grown on all kinds of soils. However, best turnip is produced on sandy loam which is friable but must contain high amount of humus.

Sowing time

	Zone	**Sowing time**
	Sub tropical	Sept. Oct.
	Intermediate (Low)	Sept.-Oct
	Intermediate (High)	April-Aug.
Seed rate	4-5 Kg/ha	(Kera Method)
	2-3 Kg/ha	(Dibbling Method)

Varieties

Purple Top White Globe: It is high yielding, medium to late variety with round shape purple top, flesh white, firm, crisp and mildly sweet flavoured. Top is small with cut leaves. It gets ready in 60-65 days and average yield is 250-300 q/ ha.

Pusa Swati: Roots are white, round and slightly flat with rat tail habit. Flesh white, sweet and mildly flavoured. Leaves are green and small to medium in size. Suitable for sowing from early Aug.-Sept. Maturity in 45-50 days. Average yield is 250-300 q/ha.

Pusa Swarnima: Roots are large, flattish round, rich in carotene content and sweet in taste. Leaves medium and green. Suitable for sowing from Oct.-Dec. Maturity in 65-70 days. Average yield is 350-375 q/ha.

Pusa Chandrima: Roots medium to large, smooth, pure white, sweet in taste. Leaves medium and green. Suitable for sowing from Oct.-Dec. Maturity in 60-65 days. Average yield is 350 q/ha.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
20	60 (120.0)	30 (66.0)	50 (85.0)

Whole of FYM along with P_2O_5, K_2O and half N be given at the time of field preparation. Remaining half be given in two split doses at the time of earthing up.

Irrigation

If seed is sown in sufficient moisture in soil, the first irrigation should be given after germination. Subsequent irrigations are given according to the soil moisture and seasons.

Thinning

This is one of the most important operations in the successful cultivation of this crop. The plants are thinned to stand 8-10 cm apart in rows.

Earthing up

This is also an important operation. After thinning, application of fertilizer, watering and then light earthing up is done. Only 2-3 cm of the upper part of the plant is covered with soil. At least, one such light earthing up is essential.

Harvesting and storage

The turnip roots are harvested when they are tender and attain the marketable size depending on the variety. The size ranges from 5-10 cm in diameter. They soon become fibrous and hard if they are allowed to grow beyond the marketable stage. The edible roots could be stored for 2-3 days at room conditions, whereas they can be stored for a longer period under cold storage at temperature 0°C and 90-95% relative humidity. It can be stored upto 8-16 weeks.

Yield: 250-300 q/ ha.

Turnip seed production

The seed of turnip can successfully be produced in hills and also under sub-tropical conditions. During Nov-Dec. when the roots are fully mature, the plants are uprooted and true to type roots are selected. All under developed, deformed diseased and off type roots are discarded.

After pruning the tap root and clipping the two-third tops, leaving the crown intact, the selected roots are replanted in a freshly prepared soil at a distance of 60 x 30 cm. Roots raised in one hectare are sufficient to plant 3-4 hectare

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
30	60 (120.0)	30 (66.0)	50 (85.0)

P_2O_5, K_2O and FYM should be applied at the time of replanting and nitrogen in three splits doses at replanting, bolting and flowering.

Isolation: Turnip should be isolated by 1000m in all the directions from any other variety of turnip crop, chinese cabbage, rape and mustard.

Roguing: Roguing of off type plants should be done before flowering, harvesting and threshing.

Harvesting: The crop is harvested for seed when the older pods turn brown. The seed stems are cut just above the crown. After cutting, the crop is piled for curing and drying. The seed is thoroughly cleaned and dried.

Seed yield: 700-800kg/ha

9.4 Insect-pest management in root crops

Flea Bettles (*Phyllotreta cruciferae)*	1. Spraying of Carbaryl 50 WP @ 2g /lit of water at evening hours
Mustard saw fly (*Athalia proxima*)	1. Carbaryl 10% D @ 20kg or Malathion 5% D @ 20kg/ha 2. Spraying of Cypermethrin @ 1 ml/lit of water at evening hours
Cabbage butter fly (*Pieris brassicae*)	1. Release of *Trichogramma chilonis* @ 50,000 adults/ha per release (6 times) at weekly interval in Mid January 2. Promotion of *Cotesia glomeratus*, potential parasitoids against cabbage butterfly larva can be encouraged by planting border row of mustard and coriander as flowering plants. 3. Foliar spray of *Bacillus thuringiensis dipel* formulations @ 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad @ 0.3 ml/r liter is found promising to control all lepidopteran insect pests in cole crops. 4. Don't spray the crop near harvesting
Mustard aphid (*Lipaphis erysimi)*	1. Release of *Trichogramma chilonis* @ 50,000 adults /ha per release (6 times) at weekly interval in Mid January 2. Promotion of *Cotesia glomeratus*, potential parasitoids against cabbage butterfly larva can be encouraged by planting border row of mustard and coriander as flowering plants. 3. Foliar spray of *Bacillus thuringiensis dipel* formulations @ 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad @ 0.3 ml/r liter is found promising to control all lepidopteran insect pests in cole crops. 4. Don't spray the crop near harvesting.
Diamond back Moth *(Plutella maculepennis)*	1. Planting border row of mustard and coriander 2. Foliar spray of *Bacillus thuringiensis dipel* formulations @ 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad @ 0.3 ml/r liter is found promising to control all lepidopteran insect pests in cole crops. 3. Don't spray the crop near harvesting

9.5 Disease management in root crops

Alternaria blight

Brown, circular spots on older leaves of the plants. These spots later show concentric rings with black colour. The disease becomes more serious in crops meant for seed production where lesions develop on stem and pods with more severity.

1. Collect seed from disease free crop
2. Treat the seed with captan or thiram (3g/kg of seed)
3. Spray the crop production with copper oxychloride fungicide 0.3% (300g in 100 L) or mancozeb/zineb 0.25% (250g in 100 L water) at 15 days interval starting from first appearance of disease on flowering branches.

10. Bulb Crops

10.1 Onion (*Allium cepa*)

The onion is a hardy cool-season biennial but usually grown as annual crop. The onion has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red and require 80 to 150 days to reach harvest.

Climate

Onions are temperature sensitive. They require cool weather to produce their tops and warm weather to produce their bulbs. However, crop can be grown well under mild climate. In areas where average annual rainfall exceeds 75-100 cm in the monsoon periods, it can be grown only as a summer crop. Temperature ranging from 12.8°C-23°C before bulbing and 20°C -25°C for bulb development is considered ideal. Most onions are sensitive to day length.

Soil

Onion can be grown on all types of soils. Green onions can be grown in a partially shady spot. However, deep friable loam (6 inches) and alluvial soils are best for successful cultivation. It is sensitive to high acidity and produces a maximum yield over a narrow range of soil reaction. The optimum range of soil pH is between 5.8 and 6.5.

Varieties

Pusa White Flat: Bulbs are medium large, flattish round with attractive white colour, 12-14% TSS and good keeping quality. This variety has yield potential of 300-325q/ha with crop duration of 120-130 days.

Pusa White Round: Bulbs medium in size, roundish with attractive white colour, 12-14%TSS and good keeping quality. This variety has yield potential of 300-325q/ha with crop duration of 125-130 days after transplanting.

Pusa Ratnar: Plants are 30cm tall and dark green leaves with waxy bloom. Bulbs are bronze deep red, obviate to flat globular, less pungent with 12% TSS and good keeping quality. This variety has yield potential of 325-350q/ha with crop duration of 150 days.

Pusa Red: Plants 55-65cm tall with 6-9 leaves/plant, bulb yield of 25-40t/ha in 125-140 days of

transplanting.

Agrifound Light Red: Bulbs are light red, globular, tight skinned 4-6cm in size, 12-13%TSS, good keeping quality, bulb yield of 300-325 q/ha. Bulb yield in 110-120days of transplanting.

Agrifound Dark Red: Bulbs are dark red, globular 4-6cm size moderately pungent with12-13% TSS, average keeping quality, gives 300q/ha bulb yield in 95-110 days of transplanting.

N-53: Bulbs are shinny red, globular in shape less pungent, TSS 11-12% poor storage capacity, gives yield of 150-200q/ha, suitable for Kharif season.

NHRDF-Red (L-28): Bulbs are attractive dark red in colour and 4.5-6.0cm in diameter.TSS 13-14%, yield is 250-300q/ha, maturity in 110-120 days after transplanting.

Hisar-2: Bulbs are bronze red in colour, flattish globular in shape, more pungent, better shelf life. Average yield 200-250q/ha.

Sowing time

Zone	Sowing	Transplanting
Sub-tropical	Oct- Nov	Dec.-Jan
Intermediate	August	October

Sowing method

Onions can be grown from seeds and sets. In the first method, about 10-12 kg seeds are sown to raise seedlings for one hectare and area wise about 5% area is required to raise seedlings for one hectare. The seeds after treatment with thiram or captan (2-3g/kg seed) are sown in raised (15-20 cm) nursery beds of 3mx0.6m size with a distance of 70cm between the beds. Seeds are sown in lines 4-5 cm apart and not more than 2-3 cm deep. After sowing beds are mulched with straw, dry grass or any such material to preserve the soil moisture. Light irrigation should be provided after two days of sowing and later as and when required. Once the seeds have germinated, the mulch material should be removed. 8-9weeks old seedlings i.e., 50-55 days of sowing are ready for transplanting at spacing of 15cm x 10cm, totalling 70-80 plants per sqm. Sets are small bulblets--about large pea size and developed from the seedlings in the nursery bed. These seedlings are not transplanted but retained in the beds till small pea size bulblets are formed i.e., after 3.0-3.5 months of sowing. These are best used as propagating material for kharif onion. Sets are planted just below the soil surface and are quick to begin growing. (But there are fewer onion varieties available as sets).

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
20	100 (200.0)	50 (110.0)	50 (85.0)

Full dose of well rotten farmyard manure should be well applied to the field, one month before transplanting. Full dose of phosphorous and potash and half dose of nitrogen should be applied before transplanting and remaining dose of nitrogen is top dressed after about a month after transplanting (i.e., before initiation of bulbs)

Intercultural operations

Keep the beds free of weeds to avoid competition for light, water, and nutrients. Onion is shallow rooted crop, so very shallow culture operation should be followed. Chemicals can

profitably be used for Control measures of weeds. Application of stomp 30EC @ 2.5 litres/ha or Basalin@ 1.0 litre /ha immediately after transplanting or before first irrigation followed by one hand weeding after 45 days can check the weeds effectively.

Irrigation

One light irrigation is given immediately after transplanting for proper establishment of seedlings. Subsequent irrigations should be provided at 7-10 days interval. In all, 15-20 irrigations are required. The most important stage of irrigation is the bulb formation and enlargement stage. The negligence at this stage results in cracking of the bulbs and low yield. Frequent irrigations delay maturity.

Harvesting

In onion, neckfall is the indication of maturity. Onion becomes ready for harvesting in 5-6 months after transplanting for dry onion (after 25-50% neck fall). The secondary bulbs developing from other bulbs, 2-3 months after transplanting, find a ready market as green onions, early in the season (October-December).Lift dry onion bulbs when they are 3 to 5 inches in diameter after the leaves have dried.

Curing

In rabi season, keep bulbs in the field for 3-5 days and then cut the pseudostem 2-5cm above the bulb and dry them in shade for 7-10 days. It will remove the excess moisture from the outer skin and neck. Onions are considered cured when neck is tight and the outer scales are dried.

Storage

Bulbs can be stored under well ventilated storage structures with low temperature (2.9°C to 29.4°C) and dry condition for 5-6 months without sprouting and without excessive loss of weight.

Yield

- Big sized onion (5.5cm and above):250-300q/ha
- Small and medium sized onions (<5.5cm): 160-200q/ha.

Onion seed production

Onion is biennial plant and requires two seasons to complete its cycle. In first year, bulbs are raised from seed and in second year, these mother bulbs are planted at 45 x 20 cm distance in October and crop is ready in April/May. Land should be free from volunteer plants.

Isolation distance

For mother bulb production, isolation distance of 5 m is required from fields of other varieties and same variety not conforming to varietal purity. To maintain varietal characteristics, two inspections- one after transplanting and second after bulbs have been lifted should be done. In seed production minimum isolation distance of 1000 and 500 m for foundation and certified seed respectively must be kept.

Inspections

A minimum of four inspections, first before flowering, second and third during flowering and fourth at maturity are required.

Seed yield

An average yield of 1000 - 1200 kg/ha can be obtained but viability of seed is just one year.

10.2 Garlic (*Allium sativum*)

Soil

Garlic requires medium black, fertile, well drained loamy soils rich in humus and potash content. The soils with pH range of 6-7 are ideal for crop growth.

Climate

Garlic can be grown well under wide range of climatic conditions and up to elevations of 1000-1300 meters amsl. It requires cool and moist period during growth and relatively dry period during maturity. The cool growing period gives more yield than warm. The critical day length for bulbing is 12 hrs. An exposure of dormant cloves or young plants to temperature of around 13-20°C for 1-2 months hastens bulbing.

Varieties

Agrifound Parvati-2 (G-408): Bulbs are bigger in size 5.0-6.0cm in diameter, creamy white colour,10-16 cloves with average diameter of 1.5-1.8cm,TSS 37%,dry matter 38% cloves are suitable for export, tolerant to common diseases, gives an average yield of 175-200q/ha.

Yamuna Safed (G-1): Bulbs are silvery white skin with creamy flesh, 4.0-4.5 cm diameter, 25-30 cloves, TSS 38%, dry matter 39.5%, suitable for export. Average yield 150-175q/ha.

Planting Time

Zone	**Planting Time**
Sub Tropical	Last week of September to last week of October
Intermediate	Last week of August to first week of October

Sowing/ Planting

Garlic is propagated by cloves (segments of compound bulb) which are detached individually from the bulb and are planted. The seed rate for one hectare is 55-60q. The cloves are planted in small plots, convenient for irrigation and Intercultural operations, at spacing of 15 cm x 7.5cm, by dibbling method. The cloves with growing ends upwards are dibbled with hand about 5-7.5cm deep and covered with loose soil using hand hoe.

Furrow planting method can also be used. Light irrigation should be given one day after sowing for proper germination. A population of 3.3 lakh plants can be accommodated in one hectare area. In certain cases, bulbils (aerial parts) can be used as propagating material.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
20	100 (200.0)	50 (110.0)	50 (85.0)

Full dose of well rotten farmyard manure should be well applied to the field, one month before transplanting. Full doses of phosphorus and potash are drilled at the time of sowing. Nitrogen is applied in three splits 30, 45 and 60 days after sowing.

Irrigation

Garlic requires light irrigation. First irrigation is given 1-2 days after planting. Subsequent irrigations are given after every 10-15 days depending on the soil type and weather conditions. Irrigation should be stopped at maturity at least 15 days before harvesting.

Intercultural operations

Garlic is poor competitor of weeds and should be controlled at initial stage. First weeding is done one month after planting and second after two months. Hoeing just before the formation of bulb loosens the soil and helps in settings of bigger neck bulbs. The weeds in garlic can be controlled by the application of Stomp (pendimethalin) 30 EC@ 2-2.5litres in 625 lt of water or 3-4ml/lt of water for one hectare followed by one hand weeding after 45 days of planting. The weeds can also be controlled by the pre-emergence application of oxadiargyl @ 90 g/ha followed by post-emergence application of quizalofop-ethyl @ 50 g/ha, applied at 2-3 leaf stage of the weeds.

Harvesting

Garlic is a crop of 4-5months duration. When the leaves start turning yellow or brownish and show signs of drying up, the crop is ready for harvest. The plants are pulled out and tied into small bundles. They are kept in shade for 5-7 days for curing and drying so that the bulbs become hard and their shelf life is prolonged. It is important to store bulbs in well ventilated rooms.

Yield: The average yield is 100 to 120 q/ha.

10.3 Insect pest management in bulb crops

Thrips	1. Sparying of metasystox 25 EC @ 1.0 ml/lit or rogor 30 EC @ 2 ml/lit or malathion 50 EC @ 2.0 ml/lit
Maggots	1. Apply carbofuron 3 G Carbofuran 3G @ 30 Kg/ha at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.

10.4 Disease management in bulb crops

Damping-off (*Rhizoctoniasolani, Fusarium spp., Pythiumspp)*

Seedlings are killed at pre and post emergence stage.

- Treat the beds (after adding manure) with formalin in 1:7 ratio with water and cover the treated beds with polythene sheet for 15-20 days before sowing. The seeds should be sown when the soil becomes free from formalin vapours.
- Treat seed with Thiram (2.5g/kg seed before sowing).
- Drench nursery beds with a mixture of Carbendazin 50 WP (0.1%) +Mancozeb 75WP (0.2%) at the initiation of damping off symptoms.

Downy mildew (*Peronospora destructa)*

Light yellow spot on root and downy growth on leaves and flowering stalks followed by necrotic lesions.

- Collect seeds from disease free crop.
- Spray the crop with Ridomil MZ (2.5g/litre of water) at the time of disease appearance. Repeat sprays at 10-15 days interval with Mancozeb (2.5g/litre of water)

Purple blotch (*Alternaria porri)*

Purple zonated spots appear on leaves and flowering stalks which usually break at the point of attack.

- Immerse bulbs before sowing in Mancozeb (2.5g/litre of water) and spray the crop at fortnightly interval starting from appearance of the disease.

Stemphylium blight (*Stemphylium vesicarium)*

Small yellow to orange spots or streaks appear in middle of leaves and on flower in middle of leaves and on flower stalks on one side.

- Spray Mancozeb (2.5g/litre of water) at 15days interval in bulbs crop or copper oxychloride+ Sandovit (1.0/ litre of water) at 15 days interval in seed crop.

Black mould (*Aspergillus niger)*

Black powdery masses of spores are borne on exterior.

- Protect bulbs from moisture after harvest and store them properly.

11. Leafy Vegetables

11.1 Beet leaf (Palak) (*Beta vulgaris* var. *bengalensis*)

Climate

It is a cool season crop. It can withstand frost better than other vegetables crops. High temperature (35-40°C) and long days cause bolting thus reduce its market value. Higher yields are obtained under short day and mild temperature conditions.

Soil

It can be grown on a wide range of soils. It thrives best on well drained loam soils. A pH range of 6-6.5 is desirable.

Sowing time

Zone	**Sowing Time**
Sub-Tropical	August to December
Intermediate (Mid)	June to September
Intermediate (High)	March-June

Spacing: 20 x 5 cm

Seed rate: 35-40 kg/ha

Varieties

All Green: Uniformly green tender leaves, heavy yielder, very early and ready for first cutting in four weeks. 6-7 cuttings can be taken and average yield is 125q/ha.

Pusa Bharati: Leaves are smooth, tender, green, without any red pigmentation, leaves ready for first picking in 30-40 days after sowing. Average yield is 500 q/ha.

Pusa Jyoti: Leaves thick, dark green, fleshy, wavy margins, suitable for September sowing. Average yield is 425 q/ha.

Pusa Harit: Plants are erect, leaves upright, thick, dark green, quick rejuvenation after cutting. Average yield is 260 q/ha.

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	80 (160.0)	25 (55.0)	25 (43.0)

Apply whole of FYM, P_2O_5 and K_2O and 1/4 nitrogen before sowing. Rest of nitrogen should be applied in splits after each cutting followed by irrigation.

Irrigation

First irrigation should be given immediately after sowing and subsequent at weekly interval for better growth of foliage.

Intercultural operations

2-3 hoeing cum weeding are required to keep away the weeds from the field. Hand weeding is advocated in the earlier stage. After every cutting weeding and hoeing should be done.

Harvesting and storage

The crop is ready for harvesting is about 4 weeks. Harvesting should be done at frequent intervals when the foliage are tender and at appropriate edible stages. One crop of prickly seeded variety in season gives 3-4 cuttings with total yield of about 50-60q/ha where as round seed varieties give comparatively more number of cuttings with a total yield of l00-125q/ha. Under low temperature (0.0°C) and high relative humidity (90-95%) leaves can be stored for 10-14 days.

Beet leaf seed production

The crop of beet leaf is raised for seed production in the same way as for green leaves production. Isolation distance of l000m should be provided in all the direction from any other beet leaf crop. Extreme male and vegetative male plants should be removed because these plants do not bear seed. Only hermaphrodite and female plants should be allowed to produce seed. Seed of beet leaf matures at different times. So, three harvesting be done and then threshed properly. An average yield of 80-10q/ha of seed can be obtained.

11.2 Spinach (*Spinacia oleracea*)

Climate

It is a cool season crop. It can withstand frost better than other vegetables crops. High temperature (35-40°C) and long days cause bolting thus reduce its market value. Higher yields are obtained under short day and mild temperature conditions.

Soil

It can be grown on a wide range of soils. It thrives best on well drained loam soils. A pH range of 6-6.5 is desirable.

Sowing time

Zone	Sowing Time
Sub-Tropical	August to December

Intermediate (Mid) June to September

Intermediate (High) March-June

Spacing: 30 x 7.5 cm

Seed rate: 35-40 kg/ha

Varieties

Prickly Seeded: It is a variety with narrow and pointed leaves. Plants are upright and vigorous, leaves blistered, thick and good yielder.

Virginia Savoy: Smooth seeded, plants upright and vigorous. Leaves with round tips, blistered, crumpled and thick. Average yield is 100-125q/ha. Suitable for mid and temperate zone.

Banerjee Giant: Plants robust, leaves large and fleshy, double the size of ordinary spinach, suitable to subtropical and mid hill zone of the province. Average yield 150-200q/ha

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
25	80 (160.0)	25 (55.0)	25 (43.0)

Apply whole of FYM, P_2O_5 and K_2O and 1/4 nitrogen before sowing. Rest of nitrogen should be applied in splits after each.

Irrigation

First irrigation should be given immediately after sowing and subsequent at weekly interval for better growth of foliage.

Intercultural operations

2-3 hoeing cum weeding are required to keep away the weeds from the field. Hand weeding is advocated in the earlier stage. After every cutting weeding and hoeing should be done.

Harvesting and storage

The crop is ready for harvesting is about 4 weeks. Harvesting should be done at frequent intervals when the foliage are tender and at appropriate edible stages. One crop of prickly seeded variety in season gives 3-4 cuttings with total yield of about 50-60q/ha where as round seed varieties give comparatively more number of cuttings with a total yield of l00-125q/ha. Under low temperature (0.0°C) and high relative humidity (90-95%) leaves can be stored for 10-14 days.

Spinach seed production

The crop of spinach is raised for seed production in the same way as for green leaves production. Isolation distance of l000m should be provided in all the direction from any other spinach crop. Extreme male and vegetative male plants should be removed because these plants do not bear seed. Only hermaphrodite and female plants should be allowed to produce seed. Seed of spinach matures at different times. So, three harvesting be done and then threshed properly. An average yield of 8-10q/ha of seed can be obtained.

11. 3 Kasuri Methi (*Trigonella corniculata*)

Climate

Kasuri methi requires a relatively cooler climate. It can tolerate frost and freezing weather. The areas where rains are heavy and continuous, growing methi should be avoided.

Soil

Kasuri Methi can be grown on a wide range of soils. The ideal soil is clay loam. The favorable soil pH is 6-7.

Sowing time

Zone	**Sowing Time**
Sub-Tropical	Sept.- November
Intermediate (Mid)	Aug. - September
Intermediate (High)	March- April, May-June

Varieties

Kasuri Methi: It is a late cultivar. Plants are small statured and erect. It takes about 150-160 days from seed to seed. Leaves are small and scented and pods are sickle shaped. 4-5 cuttings can be taken as green.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
15	60 (120.0)	20 (44.0)	20 (34.0)

Apply whole FYM, phosphorus, potash and 1/4th N at the time of sowing and remaining nitrogen@20 kg/ ha after every cutting to get green, tender and succulent leaves.

Intercultural operations

Two hoeing and weedings are enough to control the weeds. Pre plant application of Trifluralin (Treflan) @ 0.75 kg/ha along with one hand weeding keeps weed under check.

Irrigation

The first irrigation is given immediately after sowing and subsequently after every 8-10 days. Avoid water stress at pod and seed development stage.

Harvesting

The crop is meant for flavor and aroma. It is dried as spice crop. The green leaf yield of Kasuri type vary from 90-100q/ha while the common type produces an yield of 70-80q/ha.

Kasuri methi seed production

The crop is raised for seed production in the same way as for green leaves production. After one month of sowing one-two cutting of green leaves should be taken and then crop is left for raising seed. After one cutting 20 kg N/ha and then irrigate the field. It is predominantly self pollinated and an isolation distance of 10 and 5 m should be maintained for foundation and certified seed production. Crop is ready for seed harvest when pods turn brown and leaves get dry.

Green leaves yield: 90-100q/ ha

Seed Yield: 6-7q/ha

11. 4 Common Methi (*Trigonella foenum gracum*)

Climate

It is cool season crop and can tolerate frost and freezing weather. The areas where rains are heavy and continuous, growing methi should be avoided.

Soil

Methi can be grown on a wide range of soils. The ideal soil for methi is clay loam. The favorable soil pH is 6-7.

Sowing time

Zone	**Sowing Time**
Sub-Tropical	Sept- November
Intermediate (Mid)	Aug. - September
Intermediate (High)	March- April, May-June

Varieties

Pusa Early Bunching: It is an early cultivar commonly known as methi. It takes about 125 days from seed to seed.

Manures and Fertilizers

FYM *(t/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
15	60 (120.0)	20 (44.0)	20 (34.0)

Apply whole FYM, phosphorus, potash and 1/4th N at the time of sowing and remaining nitrogen@20 kg/ ha after every cutting to get green, tender and succulent leaves.

Intercultural operations

Two hoeing and weedings are enough to control the weeds. Pre-plant application of Trifluralin (Treflan) @ 0.75 kg/ha along with one hand weeding keeps weed under check.

Irrigation

The first irrigation is given immediately after sowing and subsequently after every 8-10 days. Avoid water stress at pod and seed development stage.

Harvesting

When common methi is used as leafy vegetable, the young shoots are nipped off in about one month after sowing. The picking of leaves is done by nipping 2cm above ground level leaving the stubs which produces new shoots. Avg. yield is 70-80 q/ha.

Fenugreek seed production

The methi is raised for seed production in the same way as for green leaves production. After one month of sowing one-two cutting of green leaves should be taken and then crop is left for raising seed. After one cutting 20 kg N/ha and then irrigate the field. Methi is predominantly a self pollinated and an isolation distance of 10 and 5 m should be maintained for foundation and certified seed production. Crop is ready for seed harvest when pods turn brown and leaves get dry.

Green leaves yield: 70-80q/ha

Seed Yield: 15-19q/ha

11.5 Coriander (*Coriandrum sativum*)

Coriander is an important condiment grown in almost all the kitchen garden. Its seeds, young plants or leaves are used for flavoring or garnishing the foods, curries and soups. The seeds are also considered as appetizer, digestive, carminative, tonic, antipyretic and diuretic.

Climate

It is a tropical plant cultivated in rabi season. It requires frost free climate at the time of flowering and seed formation. Dry and moderately cool weather is congenial for increasing the seed yield. Heavy rains are harmful to the crop.

Soil

It can be grown on wide range of soils. However well drained sandy loam soils rich in organic matter are quiet ideal.

Varieties

- Pant Haritma
- Narnaul Selection
- Hissar Surbhi
- IARI Selection 360
- IARI Selection 36-3

Sowing time: Last week of October.

Seed rate: 10-15 kg/ha (irrigated conditions)
25-30 kg/ha (un irrigated conditions)

Spacing: 30 x 10 cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
15	60 (120.0)	30 (66.0)	20 (34.0)

Apply whole FYM, phosphorus, potash and 1/3rd N at the time of sowing and remaining nitrogen should be applied 30 and 75 days after sowing.

Irrigation

Depending upon the climatic conditions, soil type and variety, 4-5 post sowing irrigations are given. The first irrigation is given 35-40 days after sowing and the second one 60-70 days after sowing.

Intercultural operations

Two weedings and hoeing one each after 30 and 60 days of sowing are recommended. Preplant application of Treflan (Trifluralin) @ 0.75 kg/ha or Stomp 30 EC (Pendimethalin) @ 1.0 kg/ha can effectively control measures the weeds.

Harvesting

The crop is raised for green leaves and seed purpose. For green leaves fully developed succulent leaves are nipped off along with stem after 75 days of growth. For seed purpose the

crop is harvested when 50% seeds turn yellow. After drying the seeds are separated by beating with sticks and winnowing.

Yield: 25 q/ha (irrigated)
7-8 q/ha (rainfed crop)

11.6 Amaranthus (*Amaranthus tricolor*)

Amaranthus (choulai, badi choulai) is a very popular leafy vegetable in kitchen or home gardens. It is a short duration crop. Near by the big cities it is cultivated almost throughout the year. Amaranthus is a multipurpose crop. The leaves and its tender shoots are cooked as spinach. The leaves are rich in protein, iron and vitamin A and C which is a rare example wherein these essential dietary components are combined in one.

Climate

It is grown in temperate as well as tropical climatic conditions. In India, it is grown throughout the year. However, it is mainly grown in summer and rainy season. Severe winters are not desirable for its cultivation and drought conditions may not affect much the grain types.

Soil: It can be grown on a wide range of soil. However leafy types requires fertile soils of sandy loam nature with well drained and slightly acidic. It does not perform well on heavy, poorly drained or sandy soils.

Cultivars

1. **Pusa Chhoti Choulai:** Plants are dwarf, leaves small suitable for greens, responds well to cutting. Flowers are borne in clusters in leaf axils suitable for both summer and rainy season cultivation.
2. **Pusa Badi Choulai:** Plant is tall, stem is thick, tender and green in colour; leaves large and green in colour, responds well to cutting and can be grown for longer period of time. It is suitable for summer and crop may prolong up to the end of rainy season.

Manure and fertilizers

Application of 20 to 30 tonnes farmyard manure per hectare is advisable during the last ploughing. Besides, 30-40 kg nitrogen, 40-50 kg each phosphorus and potassium are applied. The nitrogen should be applied in three or four splits. Generally, nitrogen is top dressed after each cutting. The whole quantity of phosphorus and potassium should be applied as basal dose just before sowing.

Seed rate: 2 kg /ha (Badi Choulai) and 3kg/ha (Chhoti Choulai).

Sowing

The seeds are sown thinly in lines. The distance between plant to plant is 10 to 15 cm and row to row distance is 45 cm. The distance between plant to plant is maintained by thinning particularly when it is grown for grain purposes. For vegetable purpose if thinning is not done, will not affect the yield adversely.

As far as possible, sowing of the seeds should be done at the depth 1 to 2 cm. It will ensure uniform and rapid germination. The seeds are very small (thousand grain weights 0.4-1.2 g) therefore some quantity of sand or fine powder of leaf mold or soil is mixed to get uniform distribution. It will also help in maintaining seed rate per unit area.

Irrigation

Since the seeds are very small, if irrigation is done after sowing there is risk for soil crust formation which will result in slow and poor emergence of seedlings. Therefore, it is advisable to do pre-irrigation so that sufficient moisture is made available for rapid and uniform germination. The leaf types require irrigation at frequent interval, better if irrigation is followed by each cutting. The grain type of amaranthus is drought resistant and hence crop can easily taken as rain-fed crops.

Interculture

Hoeing at early stage of crop growth will ensure good aeration and weed free crop. Being a short duration crop weeds do not pose a problem.

Harvesting

Usually, after 25 to 30 days plants are pulled as a whole and washed properly. The root portion along with hard portion of stem is removed. Instead of uprooting whole plants, clipping of full grown side leaves is done, many times tops of the plants may also be cut. The first cutting is done 25 to 30 days after planting and thereafter at 6 to 8 days interval. Crop is over in 6 to 8 cuttings or so.

Yield

The average yield of greens is about 60 to 80 quintals per hectare depending upon cultivars, climatic condition and management of the crop.

Storage

Its leaves are very perishable in nature. They cannot store for more than few hours under ordinary conditions.

11.6.1 Insect-pests management of Amaranthus

Amaranthus is not harmed by any insect pest seriously, common insects viz. leaf webber, leaf hopper, stem weevil, caterpillars and ants are seen in the crop. On leaf type of amaranthus where cutting of the leaves is a regular practice and hence, insects may not be a problem. Only at initial stage, one spray of Malathion at the rate of 1.5 to 2 ml per litre of water may be done. It is not advisable to use insecticide in amaranthus because leaves are cooked as vegetable.

11.6.2 Disease management of Amaranthus

Leaf spot (*Cercospora*spp.): Small brown spots appear on the leaves. Spots are roundish with concentric rings in the beginning which later increase in size and may coalesce.

Control measures

- Remove affected leaves.
- Spray Bordeaux mixture (5:5:50) or Blitox (0.3%) three times at an interval of 15 days.

White rust (*Albugo bliti Kuntze*): White blisters appear on the lower surface of the leaf and opposite each blister on the upper surface a yellow patch develops. Leaves may wilt and die when incidence becomes severe.

Control measures

- Follow crop rotation.
- Spray Dithane M-45 at 0.2 per cent.

11.7 Basella (*Basella alba*)

Basella is populary known as Poi. Basella is a climbing plant. The stem is succulent, the leaves are dark green thick and succulent. The arrangement of leaves on stem is alternate, they are broad, pointed at the apex. Flowers are white or pink in colour. The fruit is enclosed in fleshy perianth. Basella is commonly grown in North-East and South India. The tender young leaves and stems are cooked as vegetable like spinach or palak, Leaves makes nice pakoras. Violet colouring matter is obtained from ripen fruits which is used for colouring food. The juice of tender leaves is used in constipation. The leaves are used as poultice for curing swelling etc.

Climate

The basella can be grown on a wide range of climatic conditions. Frost is harmful and so also extremes of hot climate. However, it thrives best under warm and moist climate. It can be grown successfully under partial shade with the advantage of getting broad succulent leaves.

Soil

Basella can be grown on a wide range of soils. However, heavy soils are not suitable. The best soil which is sandy loam type containing or has been supplied with adequate amount of well rotten farmyard manure or compost. The soil should be well drained.

Cultivars

Generally, two types of cultivars are grown which are used for vegetable purpose.

i) Cultivar with reddish petioles and stems.

ii) Cultivar with green leaves, petioles and stems.

Both the types of cultivars are grown in Assam, West Bengal and South India whereas green-leaved cultivars are preferred to grow in Uttar Pradesh and Punjab.

Manure and fertilizers:

Application of 20 to 30 tonnes of well rotten farmyard manure or compost should be done in the soil well in advance to planting. Besides, nitrogen 60 - 80 kg, phosphorus 60 - 80 kg and potassium 40 - 60 kg per hectare required for better yield. Application of nitrogen should be done in two to three splitted doses. Phosphorus and potassium are applied as basal doses.

Sowing

Basella is raised mainly by seeds. It can also be raised by stem or root cuttings. The sowing is usually done in March to May in the northern and eastern plains of India whereas sowing time in south India is June and October to November. In the hills, basella is sown in March to April. When it is raised by stern or root cutting, planting is restricted to only monsoon season or early summer when success is high.

In order to raise one hectare crop of basella about 12 to 15 kg seed per hectare will require. Basella can be raised by directly sowing the seeds in the main field or by raising seedlings in nursery and then transplanting them in the main field.

Spacing

Distance of planting is 45 x 35 or 60 x 60 when plants are allowed to grow on the ground. When plants. are trained on Machans made up of bamboo sticks and joined with jute string or trained on trellises. In such cases, distance of planting can be reduced to 20 to 30 cm between plant to plant.

Irrigation

Basella is a foliage plant the leaves and soft portion of stems are used as vegetable. It requires adequate quantity of water at frequent interval. Inadequate watering will lead to poor development of leaves. The succulency of leaves, their colour, weight of leaves, attractive appearance will be affected if water is not available in time. The spring-summer crop requires watering at narrow interval compared to winter season crop. However, rainy season crop does not require irrigation except when there is long spell of drought.

Interculture operations

In order to provide good environment for plant growth, light cultivation is essential. Besides, it will also help in keeping down the weeds. Moreover, cultivation acts as a mulch. Hoeing is best. It is done with Khurpi. It is advisable to put some soil very near to the base of the plant which will prevent plants from the direct contact with water. Water stagnation should always be avoided, and aeration in the root zone helps better growth of vines.

Harvesting

The leaves become ready for harvesting 60 to 75 days after sowing the seeds. The crop become ready for harvesting earlier also when it is raised by stem or root cuttings, it takes about 45 days.

Yield

The yield is low in the first cuttings, which increased in subsequent cuttings when plants are fully developed and spread well. The total yield of 150 to 200 quintals per hectare is obtained depending upon the management practices followed for growing the crop.

11.7.1 Insect-pests and diseases of Basella

Basella plant is more or less free from any serious insect-pests except caterpillars of erimine moth sometimes seen. As regards diseases, a few are harmful to the crop viz., damping off iPythium aphanidermatum Fitz), leaf spot (Acrothecium basellae), Alvarez-Garcia, Fusarium moniliformae (Sheldon and Cercospora sp.) and mosaic diseases. The best control measures would be to sterilize the soil, if it is possible, treat the seeds before sowing, provide drainage and aeration, have planting at wide spacing. As far as possible, use of chemicals on leaves should be avoided.

12. Tuber Crops

12.1 Potato (*Solanum tuberosum*)

Potato is the fourth major food crops of the world after rice, wheat and maize. Being a major source of carbohydrate it is often used as a substitute for cereals and is grown in almost every country. It also contains essential nutrients like protein, minerals (Ca, P and Fe) vitamins (B1, B2, B6 & C) and amino acids like leucine, trytophane and isoleucine.

Climate

Potato is a cool season crop however at low temperature vegetative growth is restricted and at freezing point temperature irrecoverable frost injury occurs to the plant. Long days coupled with high temperature conditions promote vegetative growth without formation of tubers and short day with low temperature induce tuberization. It should be grown when maximum day

temperatures are below 34°C and night temperatures are not above 20°C. Optimum temperature for good plant growth is 15-20°C. Most of the cultivars do not tuberize when the prevailing night temperature is above 21°C.

Soil

Potato can be grown in all types of soils like alluvial, black, red and laterite having pH range of 6.5-7.5 and electrical conductivity (EC) below 0.5%. Alkaline or saline soils are not suitable for its cultivation.

Varieties

Early Maturing Group: (Requires 70-90 days after planting to give economic yield)

Kufri Chandermukhi: Tubers are creamish white ovoid with shallow eyes. The variety is susceptible to major diseases, however it is suitable for processing also. Average yield is 200-250 q/ha.

Kufri Lauvkar: Tubers are round, creamish white with medium deep eyes. This variety is suitable for processing when grown in warmer areas of central plains. Tolerant to heat and succeptible to major diseases. Average yield is 200-250 q/ ha.

Kufri Pukhraj: Tubers are ovoid, yellow with medium deep eyes and develop faint purple colour on exposure to sun. This variety is resistant to early blight, moderately resistant to late blight and immune to wart. Early bulkar and suitable for low input ecosystem. Average yield is 350-400 q/ ha.

Kufri Ashoka: Tubers are ovoid, creamish white with medium deep eyes. This variety is succeptible to major potato diseases. Average yield is 250-300 q/ ha.

Kufri Khyati: Tubers are ovoid, creamish white with medium deep eyes. This variety is moderately resistant to early and late blight. Early bulking variety suitable for high cropping intensity. Average yield is 250-300 q/ ha.

Kufri Surya: Tubers are oblong, creamish white with shallow eyes. This variety is heat tolerant and can be grown in areas having night temperature above 20°C. Suitable for early planting in plains. Average yield is 200-300 q/ ha.

Medium Maturing Group: (Requires 90-100 days after planting to give economic yield)

Kufri Jyoti: Tubers are round, creamish white with shallow eyes. This variety is suitable for processing when grown in warmer areas of central plains. The variety carries moderate resistance to early and late blight. It is immune to wart, has wider adaptability and slow rate of degeneration. Average yield is 200-250 q/ha in hills and 300q/ha in plains.

Kufri Bahar: Tubers are ovoid creamish white with medium deep eyes. The variety is early bulking, immune to wart, tolerant to Gemini viruses and has a slow rate of degeneration. Average yield is 300-350 q/ha.

Kufri Chipsona-1: Tubers are ovoid, creamish white with shallow eyes. The variety possesses resistance to late blight and is suitable for preparation of chips and French fries. Average yield is 300-350 q/ha.

Kufri Arun: Tubers are ovoid, red with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 300- 350 q/ha.

Kufri Pushkar: Tubers are ovoid, yellow with medium deep eyes. The variety possesses moderate resistance to late blight, resistance to early blight and immunity to wart Average yield is 300- 350 q/ha.

Kufri Shailja: Tubers are ovoid, creamish white with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 300- 350 q/ha.

Kufri Chipsona -3: Tubers are ovoid, creamish white with shallow eyes. The variety possesses resistance to late blight. The tubers have high dry matter, low reducing sugars and low phenols. Variety is highly suitable for making chips and French fries. Average yield is 300- 350 q/ha.

Kufri Himalini: Tubers are ovoid, creamish white with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 300- 350 q/ha.

Kufri Frysona: Tubers are oblong, creamish white with shallow eyes. The variety possesses field resistance to late blight and immunity to wart. The tubers have high dry matter, low reducing sugars and low phenols. First Indian variety suitable for making French fries. Average yield is 300-350 q/ha.

Kufri Girdhari: Tubers are ovoid, creamish white with shallow eyes. The variety possesses field resistance to late blight in foliage and tubers. Average yield is 300-350 q/ha.

Late Maturing Group: (Requires 110-130 days after planting to give economic yield)

Kufri Sindhuri: Tubers are medium in size, round in shape, red in colour with deep eyes. It is moderately resistant to early blight, tolerant to PLRV and has slow rate of degeneration. Suitable economic yields even under low fertility conditions. Average yield is 300-350 q/ha.

Kufri Badshah: Tubers are ovoid, creamish white with shallow eyes. It is moderately resistant to early blight, late blight and resistant to potato virus X. Average yield is 300-350 q/ha.

Planting time

Zone	Sowing time	Harvesting time
Sub-tropical		
Autumn crop	Sept.- Oct.	Jan.- Feb.
Spring crop	2ndfort night of Jan.	April -May
Intermediate (Low)	Sept.	Dec.-Jan.
Intermediate (High)	April-May	Sept.- Oct.

Seed source

Obtain the seed from a reliable source. It is better to replace the seed every 3-4 years. The yield is reduced progressively if the same seed is used year after year.

Green manuring

Sow 50 kg/ha of sunhemp or dhaincha from end of June to first week of July. Burry the crop after 7-8 weeks of sowing to allow proper decomposition before potato planting.

Land preparation

Plough with mould board or disc-plough, followed by disc-harrow or the tiller, depending upon the soil type. In loamy sand soil, disking alone is sufficient. Apply FYM after preparatory tillage just before planting as this practice is more beneficial than incorporating into soil through

cultivation. If weeds or stubbles of the previous crop are not problem, potato can be grown with minimum tillage without loss in yield.

Seed rate

Autumn Crop: 25-30q/ha

Spring Crop: 16-20 q/ha.

Grade: 30-35 g, 3-5 cm. diameter and with 2-3 sprouts.

Good quality and disease free seed should be used. The seed should be produced by using the seed plot technique. If the seed raised from autumn crop is to be used for spring planting, its dormancy should be broken by giving **triple treatment:** Dip potato tubers for 1 hour in 1% Thiourea + 1ppm GA3 followed by 48 hours treatment in 3% Ethylene Chlorohydrin under air tight conditions. Dry the treated tuber pieces in shade before planting.

Take out the whole tubers from cold storage 10-15 days before planting and keep in shady place under diffused light condition in thin layer on the floor to facilitate sprouting. Treat the seed tuber with mancozeb @ 4-5 g/ litre of water for 10 minutes. For treating one quintal of seed tubers, 50 litres solution is required and same solution can be used for 3-4 times after which fresh solution is to be prepared.

Planting

Seed tubers may be manually planted on ridges using a ridger. Semi- automatic or automatic planters are recommended where tractor power is available. Planting should be done at a depth of 3-5 cm keeping the sprouts upward. During planting care should be taken that the seed tubers do not come in direct contact of the fertilizers that have been applied as basal dose.

Spacing

Spacing (cm)	Size (g)	Plant population/ha
60x15	35-40	1, 11, 000
60x20	40-50	83,000
60x25	50-55	67,000

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
50	120 (250)	60 (132)	120 (204)

Apply whole of phosphorus and potash along with ½ nitrogen at the time of planting. Rest of nitrogen should be top dressed in two split doses at 25-30 days after planting and 40 days after planting followed by earthing up.

In case of micro-nutrient deficiency, apply Zinc sulphate @ 25 kg/ha, Sulphur @ 8.0 kg/ha and Borax @ 10.0 kg/ha at the time of final land preparation.

Irrigation

Adequate irrigation is essential for proper growth and yield of potato. Stolon formation, tuber initiation and tuber development stages are the critical stages for irrigation. Give one light irrigation, if necessary, before planting to ensure uniform germination. Irrigate the crop at an

interval of 7-10 days after earthing up. The level of irrigation water must not exceed 3/4th part of ridges. Total water requirement for the crop varies between 350-550 mm. Stop irrigation 10-15 days before harvesting the crop to allow the tuber skin to become firm.

Earthing-up

Earthing up is necessary in potato because proper development of tubers depends upon aeration, moisture availability and proper soil temperature. It also prevents greening of tubers. First earthing up is done 25-30 days after planting and second after 10 days of the first one. A double mould board plough or a ridger should be used for earthing up.

Weed Control measures

Any one of the following herbicides can be used for control of weeds

Herbicide	Dose/ha	Time of application
▪ Stomp 30 EC (Pendimethalin)	2.5 L	Pre-emergence application after the first irrigation but before the emergence of the crop.
▪ Arelon70 WP (Isoproturon)	1.25 kg	-do-
▪ Atrataf 50 WP (Atrazine)	500 g	-do-
▪ Lasso 50 EC (Alachlor)	5.0 L	-do-
▪ Lasso (Alachlor)	2.5L+250g	-do-
▪ Atrataf (Atrazine)		

Harvesting and grading

Harvest the crop when haulms start yellowing and falling on the ground. The harvesting operation should be completed before the temperature rises above 30°C to avoid rotting due to high temperature. It is better to cut the haulms 10-15 days before harvesting when irrigation has been stopped. Apply mancozeb @ 2.5 g/litre of water on the cut portion of haulms. Harvest the crop manually with spade or mechanically with the help of 1-4 row potato diggers. Cure the harvested tubers under shade for 10-12 days for hardening. The height of the stack should be 1-1.5 m and width 3-5 m. Discard cut, rotten, insect damaged and bruised tubers after harvest. As per market demand, grade the tubers into small (<25 g), medium (25-50 g), large (50-75 g) and extra large (>75 g) on the basis of their size. After grading pack them in gunny bags and keep in cool places till the produce is sent to market or cold stores.

Storage

Store the table varieties in cold storage at a temperature of 2°-4°C and at 80-85% relative humidity. The low temperature checks sprouting and rotting and high relative humidity reduces weight loss of tubers. Store the processing varieties in cold storage at temperature of 10°-12°C and 80-85% relative humidity.

Seed plot technique

This technique aims at raising a healthy seed crop of potato in plains during the period of low aphid incidence. This pest is responsible for transmitting the viral diseases like leaf roll, PVX, PVY and PVA. For the seed crop, healthy seed potato free from viral infection should be obtained and planted in autumn i.e. first week of October. Sowing at a spacing of 50x15 cm. would ensure the development of a large percentage of seed sized tubers. A hectare of seed crop

will produce enough seed for planting 8 hectares of the crop. Normal plant protection measures should be adapted to control aphids and other insect pests. Rogue out otherwise unhealthy plants noticed during the growing season to ensure the production of better quality seed. Towards mid - December, irrigation may be restricted and later withheld completely so that the haulms wilt and fall down. As soon as there are 20 aphids per 100 leaves, cut the haulms. Allow the tubers to mature in soil for about 15 days. The harvested crop may be graded and moved to cold storage for planting in the following autumn season.

Physiological disorders

Uneven sprouting in field: Adequate crop stand cannot be maintained due to this disorder which happens due to:

Control measures:

- Planting immediately after their removal from cold storage.
- Soil moisture deficiency
- Untreated cut tuber pieces if infected by the fungus.
- Held tubers in storage till end of dormancy period.
- Treat the cut tuber pieces with 0.25% Diathane M-45 for 10 min.
- Place tubers somewhat deep, particularly in light soil with the cut surface facing downwards.

Dormancy: Dormant or even semi-dormant tubers do not sprout readily after planting causing delayed and erratic crop stand. This disorder becomes problem when two potatoes are taken in rotation and tubers produced in the hills are used as seed immediately after the harvest.

Control measures:

- In advanced stage of dormancy, cutting of tubers may terminate dormancy.
- Cut tuber pieces are immersed immediately in 1% thiourea solution for one hour and then plant them as soon as possible.
- Give triple treatment to the dormant seed.

Greening: In field potato, tubers exposed to sunlight becomes green due to formation of chlorophyll pigment. Such tubers contain higher amount of glycoalkaloids like solanine and chaconine. The tubers become bitter in taste and non edible.

Control measures:

- Cover the exposed tubers with the field soil especially after severe rains.
- Follow high ridge planting.
- Choose varieties with profuse foliage.

Black or hollow heart: Insufficient availability of oxygen to the tubers is said to be one of the important factors causing black/ hollow heart disorder. The affected tubers have black discoloration in their central tissues, which later on get dried and form the cavities as hollow heart. Large sized tuber varieties are prone to this disorder.

Control measures:

- Avoid excessive use of fertilizers, irrigations and planting at wider spacing because all

these factors are favourable for the production of large sized tubers which are susceptible to hollow heart.

- Apply irrigation at short interval so that the soil temperature may not exceed 32°C during tuber development and maturity.
- Avoid raising temperature above 32°C during transit and storage of potato by avoiding piling and stacking too high and maintaining proper ventilation in the stores.

12.2 Insect and pest management in potato

Cutworm (*Agrotis* spp)	1. Deep ploughing of fields before planting 2. Use Chlorpyriphos 1.5% D @ 20 kg/ha as soil treatment before sowing 3. Broadcasting of Carbofuron 3G @ 30 kg/ha
Potato aphids (*Myzus persicae*)	1. Early sowing of crops (September and October beginning). 2. If 20 or more aphids have been observed on 100 compound leaves, spray dimethoate 30 EC @ 2 ml or metasystox @ 1.0 ml/lit or Malathion 50 EC @ 2 ml or imidacloprid @ 0.3 ml/ lit of water at 15 days interval
Potato leaf hopper	1. Seed treatment with thiamethoxam 70 WS @ 3g/kg seed or Imidacloprid (Gaucho) @ 5g /kg seed before sowing. 2. Use of delta traps or sticky traps @ 10 /ha 3. Foliar spray of imidacloprid (0.3 ml/lit) during the vegetative stage of the crop (before flowering) 4. Sparying of metasystox 25 EC @ 1 ml/lit or rogor 30 EC @ 2 ml/lit or malathion 50 EC @ 2 ml/lit.
Hadda beetle	1. Collection and destruction of eggs, grubs, and pupae from leaf surfaces 2. Sparying of Carbaryl 50WP (2 g/litre of water) or Acetamiprid 20 SP @ 0.3 ml/lit or Malathion 5% dust @ 20-25 kg/ha
Potato tuber moth (*Gnorimoschema operculella*)	1. Don't leave potato tubers exposed in the field. 2. Store potato in the godowns with 5-7mm thick layer of sand/ wheat/ paddy straw. 3. Keep the godown clean and fumigate with Methyl bromide @ 800g/1000cft.
Root knot nematode (*Meloidogyne* spp.)	1. Treat the soil with Carbofuron 3G@30kg/ha before sowing. 2. Follow crop rotation. 3. Grow marigold as inter crop.

12.3 Disease management in potato

Early blight (*Alternaria solani*)	
Concentric rings appear on leaves resulting into necrosis of tissue and its defoliation. In severe infection, stems and tubers may also get infected.	1. Tubers should be free from disease. Treat the tubers with mancozeb (300g/100 litre water) before sowing 2. Spray crop with zineb/copper oxychloride or mancozeb@ 0.25% at 10-15 days interval. 3. Follow high ridging to avoid tuber infection.
Late blight (*Phytophthora infestans*)	
Symptoms first appears on margin leaves as small brown patches which kill foliage in few days. Decaying crop under cloudy and wet Weather conditions often emits an offensive odour. In severe incidence whole of the field gives burnt appearance. The tubers are also infected.	1. Collect potato tubers from disease free areal field and treat them. 2. Use disease resistant varieties. 3. Give one prophylactic spray 30-40 days after sowing with zineb/mancozeb (0.25%) or copper oxychloride @ 0.3%. Give at least one spray of 0.25% metalaxyl + mancozeb on appearance of disease. Sprays may be given at 10 days interval depending upon weather conditions. 4. Follow high ridging and avoid over flooding/ irrigation during infection. 5. Trace out primary infection in field and try to remove infected leaves/plants in early stages to reduceprimary inoculum before giving spray.
Leaf roll and mosaic	
Symptoms are evident on leaves of potato. These diseases can be managed by growing disease free seeds.	1. Rouging out of infected plants from field should be done as soon as disease is detected 2. Dehaulm (removal of haulm) in third or fourth week of December when infestation starts. 3. Spraying of imidaclopoid (0.5 ml/litre) to control insect vector (aphid).

13. Legume Crops

13.1 Peas (*Pisum sativum*)

Pea is one of the important vegetable crops grown in almost all parts of region.

Climate

It is cool weather crop and grow best at the optimum mean monthly temperature of 10°C to 18°C. Pods and flowers are damaged more seriously by frost than the leaves and stems. Hot and dry weather interferes with the setting of seed and lowers the quality of pods.

Soil

Peas grow on a variety of soils ranging from light sandy loam to clay. Best results are obtained on well drained friable loamy soils. It does not perform well on acidic soils and in soils with pH below 5.5.

Varieties

P-89: Mid season variety, plants medium dwarf, vigorous with long green well filled pods, 9-10 grains/pod, crop ready in 85-90 days for first picking and heavy yielder. Seed is wrinkled, Average yield 150-175 q/ha.

Bonneville: Mid season variety, plants medium tall, with long green well filled pods, sweet and bold grains, crop ready in 85 days and heavy yielder. Seed wrinkled. Average yield 175 q/ha.

Arkel: The plant is dwarf but the growth is vigorous, flower borne in double on few lower nodes and single afterwards. Pods are attractive dark green, about 8.5 cm long incurved towards the sutures and pointed distal end with well filled 7-8 seeds. Suitable for fresh market and dehydration. Pods are harvested in 55-60 days.

Pant Sabji Matar-3: This is an early season variety. Plants are dwarf with dark green foliage. Pods are long, curved well picking starts on 60-65 days after sowing; gives an average yield of 90q/ha.

Pant Sabji Matar 5: It is an early maturing variety and gives first picking in 60-65 days after sowing. Plants are dwarf with green foliage. Pods are long and curved towards the tip. Seeds are wrinkled and green at maturity stage. This variety is resistant to powdery mildew. Average green pod yield is 90-100 q/ha.

Azad P-l: This is a high yielding mid season variety matures in 90-95 days with 100q /ha yield.

Azad P-2: It is powdery mildew resistant variety. Plants are tall (130-150 cm), erect, white flowers, bear 20-25 pods (double podded), erect, white flowers, bear 20-25 pods (double podded). Pods are medium sized with 6-7 ovules; nearly straight; horticultural maturity duration is 90-95 days with 120q/ha green pod yield; physiological maturity duration is 125-130 days; wrinkled and brown seeds; suitable for cultivation under late sown conditions.

Azad P-3: Early maturing, Pods medium sized, thick, straight with green bold seeds; gives an average yield of 80q/ha.

Pusa Pragati: Pods are long, green with 9 seeds per pod, first picking in 60-65 days after sowing. Resistant to powdery mildew. Average yield is 70 q/ha.

Sowing time

Zone	**Sowing time**	
Sub-tropical	Last week of October-	*Early crop*
	Mid Oct.-Mid Nov.-	*Main crop*
Intermediate (Low)	Mid Sept.-Oct.	
Intermediate (High)	1st Crop-	Oct.-Nov.
	2nd Crop-	May

Seed rate

- Main crop: 60 kg/ha
- Early crop: 120 kg/ha

Spacing

- Main crop: 20 x 10 cm
- Early crop: 20 x 5 cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
20	50 (100)	60 (132)	50 (85)

Apply whole of FYM along with N, P_2O_5 and K_2O at the time of field preparation.

Irrigation

During dry season apply light irrigation at an interval of 10-15 days. One or two irrigation at the time of flowering and fruit set are essential.

Staking

In case of tall varieties it is advisable to provide stakes to plants to harvest better quality pods.

Intercultural operations

The field should be kept free from weeds by giving two weedings and hoeings after four and eight weeks of germination. Usually two hand weedings are sufficient. The weeds can also be controlled by application of pre-sowing herbicides Fluchloralin@ 0.75 a.i./ha or Pendimethalin @ 1.0 kg a.i. /ha.

Harvesting and storage

Harvesting of green pods must be done at proper maturity stage. Green pods of the early, mid and late varieties are ready for harvest in 50-55, 60-65 and 70-75 days after sowing respectively. Only 2-3 pickings in early crop and 3-4 in mid season/late crop should be done. Proper storage at low temperature (0°C) and relative humidity (88-92%) may prolong the availability duration of green peas for 2-3 weeks and reduce the losses due to fungal diseases.

13.2 Broad bean (*Vicia faba)*

The broad bean (faba bean or horse bean or bakla bean) is a distinctive with a square, erect stem grows up to about 100 cm height in case of tall varieties and up to 30 cm in case of dwarf varieties. Stem usually, does not form branches. Broad bean is pollinated by insects and bears clusters of upright pods in the axils of the leaves along the stem. The pods are formed in cluster of 5 or more fleshy beans.

Sometimes, an illness which is known as ‘favism’ is caused due to allergy to pollen and to green pods of broad bean in some people.

Climate

Broad bean is hardy plant. It is grown mainly at higher altitudes where the climate is relatively cool. It is the only bean which can withstand cold (temperature up to 4°C) therefore, it is grown as winter crop.

Soil

Broad beans do well in a rich heavy loam soils free from water logging. Acidic soils are not good for broad bean. Liming may improve the soil reaction. It can tolerate salinity up to some extent. Land should be prepared thoroughly by digging the soil deeply.

Varieties: Local

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
10	20 (35.0)	50 (108.0)	40 (68.0)

Sowing time: September-October February-March

Spacing: 45cm x 10-15 cm

The germination of broad beans is low i.e., less than 75 per cent. It is advisable to sow some extra seeds at a place and transplant them to fill in gaps. The seeds germinate I 10-15 days after sowing. It is advisable to soak the seed for overnight prior to sowing.

Seed rate: 70 - 100 kg

Irrigation

Broad bean is a hardy crop cannot withstand drought. Therefore, light irrigations should be given at a regular intervals of 12-15 days or so.

Intercultural operation

Regular hoeing should be done around the plants, especially when they are small. These operations will also helpful in keeping down the weeds besides providing good environment for plant growth.

Staking

Tall varieties may be given support with wooden sticks or twigs against wind. Place stakes or canes at 1 meter intervals down both sides of the double rows close to the beans. Then tie around the stakes with twine 30 cm to 60 cm above the ground. Sometimes, side shoots from the base of the stems are removed. When plants having 5-6 flowers, pinch out the growing points at the top of the stems. This operation encourages the formation of pods and discourages aphids (blackfly) which like to feed on the growing points and youngest leaves.

Harvesting

The pods are ready for harvesting in 3-4 months for spring sowing; 6-7 months for autumn sowing. Very young pods are preferred by most people. The beans are harvested at the plant are used as dry-shell beans. Pods are picked by a quick downward movement of the hand.

Yield: 70-100 quintals of green pods per hectare.

13.3 Insect-pest management in legume crops

Pea maggot (*Melanagromyza phaseoli)*	1. Broadcasting of Carbofuran 3G @ 30 Kg/ha at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.
Pea leaf miner (*Chromatimyia horticola*)	1. Broadcasting of Carbofuran 3G @ 30 Kg/ha at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.

Pea pod borer (*Maruca testulalis*) and *Helicoverpa armigera*	1. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours or malathion @ 2 ml/lit of water at evening hours. 2. All matured fruits should be picked before spraying.
Pea thrips (*Thrips* spp.)	1. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours or malathion @ 2 ml/lit of water at evening hours 2. All matured fruits should be picked before spraying.
Pea aphid (*Acyrthosiphum pisum*)	1. Spray Carbaryl 50 WP @ 2 g/lit of water at evening hours or malathion @ 2 ml/lit of water at evening hours 2. All matured fruits should be picked before spraying.

13.4 Disease management in legume crops

Powdery mildew (*Erysiphe polygoni*)

White floury appearance on stem, branches, leaves and pods. Severeinfection results into stunted growth and reduced yield.

- Spray dinocap 0.05% (50 ml in 100 1 water) or wettable sulphur 0.2% (200g/1001 water) just on the appearance of disease at 10 days interval depending upon disease severity.

Ascochyta blight (*Ascochytapinodes, A. pinodella, A. pise)*

Brown spots appear on foliage andstems of infected plants. The roots of such plants turn brown.

- Use healthy seed for sowing.
- Treat the seeds with carbendazim (3g/kg seed).
- Spray affected plants with carbendazim 0.1% 0(100g/100 L water), mancozeb or zineb 0.25% (250 g/100 L water).

Wilt and root rot (*Fusarium oxysporium, F. pisi and F. solani*, *Rhizoctoni*, sp., *Phoma* sp.)

Control measures:

- In true wilt, the plants wilt without yellowing while in root/ collar rot, rotting of roots and collar region starts with yellowing of lower most leaves followed by wilting.
- Treat the seed with carbendazim or thiram@2 g/kg seed in problematic field.
- Avoid early sowing in badly infested area.
- Follow 3 year crop rotation in infected held preferably with cereals

14. Exotic Vegetables

14.1 Broccoli *(Brassica oleracea* var. *italica)*

Sprouting broccoli belonging to the family brassicaceae is an important Cole crop after cabbage and cauliflower. It is one of the most nutritious cole crops. It has a very powerful anti-cancer compound, glucosinolate, which provide protection against bowl cancer.

In Jammu, broccoli is gaining popularity during last few years and provides ample opportunity for successful cultivation of broccoli due to the mild climatic conditions prevailing in and adjoining areas. Broccoli head is used as a salad, in soups, pickles and in cooked form.

Climate

It is a cool season crop. The temperature of 20-25°C is optimum for its proper growth and 15-20°C for heading stage. High temperature leads to formation of loose heads and bolting thereof.

Soil

Deep loamy soil is best suited but it can be grown in a wide range of soils. The pH of 5.0-6.5 is optimum.

Varieties

Palam Kanchan: It is a late maturing variety. It has long, broad, bluish-green upright entire margin leaves with prominent white midrib and veins. The head is large, compact, attractive and yellowish-green in colour. The heads matures 140-145 days after transplanting. The average yield potential is about 250-275q/ha.

KTS-1: It is a medium-tall (65-70cm) variety. Foliage is waxy and dark green with slightly wavy margins. Heads are solid green with small heads slightly raised at the centre. The main head weight is 350-450g. Its matures in 90-105 days after transplanting under temperate climate, while 5-10 days earlier in the tropical plains. Average yield is 220-250 q/ha.

Palam Samridhi: This is a high-yielding variety. Its large terminal head weight about 300-400g each. Average yield is 250-275 q/ha.

Palam Vichitra: It has a medium open, dark green leaves with reddish tinge. The head is medium, compact and purple coloured. The heads matures 115-125 days after transplanting. The main head weight is 400-500g. The average yield potential is about 225-250 q/ha.

Seed rate: 300-400 g/ha.

Sowing time

Zone	Sowing	Transplanting
Subtropical	Sept.-Oct.	Oct.-Nov.
Intermediate (low)	Aug.-Sep.	Sept.-Oct.
Intermediate (high)	March-April	April-May

Spacing: 60 cm x 45 cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	120 (250.0)	60 (132.0)	60 (102.0)

The full dose of P and K and half N are applied at the time of transplanting and remaining half of N be applied as band dressing in two split doses, first one month after transplanting and second at the time of head initiation as band dressing.

Integrated Nutrient Management

Micronutrient requirement of broccoli is very high. Molybdenum and boron may be supplied by soil application or foliar sprays. Soils with a pH above 7 affect the availability of boron. In soil application 500g ammonium molybdate and 10-15 kg borax/ha helps in controlling the deficiency. Weekly sprays of 1-2% urea 20 days after transplanting gives better growth and

increase the yield. Three foliar sprays of 0.3% borax after 20, 35 and 50 days after transplanting is beneficial in increasing the yield and checking the browning disorder.

Irrigation

Watering is done immediately after transplanting. Broccoli needs sufficient moisture in the soil for uniform and continuous growth of plants. Frequent irrigation at 10-15 days are given depending upon weather conditions. Dry condition adversely affects the quality and yield of shoots.

Intercultural operations

2-3 hand hoeing and weeding is recommended to break the surface crust for better aeration and water absorption. Earthing up the crops 35 days after transplanting and immediately 2^{nd} hoeing/weeding and application of 2^{nd} dose of nitrogen.

Harvesting and storage

Heads having 10-15 cm stems should be harvested with a sharp sickle/knife when its bud clusters are green and compact. Central head weight about 300-600g. If harvesting is delayed the bud clusters become loose. After harvesting the heads are sorted, graded packed in baskets and sent to market. They should be cooled at 4°C and then packed with ice in crates. They can be stored well for 7-10 days at 4°C.

Broccoli seed production

The field selected for seed production should be fertile, loam or clay loam having good drainage. For certified seed production *in situ* method is preferred whereas for breeder seed production, the *ex situ* method of seed production is recommended.

Roguing

Only healthy curds, true to type and free from diseases are allowed to remain in the field for raising seed. Another rouging should be done at bolting stage to remove early and extremely late bolters.

Isolation

Seed crop of broccoli should be isolated by 1600 m distance from other varieties of broccoli and other cole crops like cabbage, knol-khol, brussels sprout etc. grown for seed production.

Harvesting and curing

The flowering appears after 30-35 days of replanting of the selected knobs and there after pod setting takes place. Care should be taken to see that sufficient insect pollinators are available at the flowering time. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days more.

Seed yield: 350-400 Kg/ha.

14.2 Asparagus (*Asparagus officinalis* L)

Asparagus appears early in the spring and when once established will produce for over many years. It is cultivated for its tender shoots, commonly known as spears. These spears are considered as a delicacy in preparation of soups, and other vegetable products. It starts yielding a sizeable crop after about three years and with good care given an economic yield for about 10-15

years and the yield goes on increasing for 6-7 years, then remains uniform up to about 12 years, after which it gradually declines.

Climate

Asparagus grows well in cool regions, where the day temperature ranges between 24.0-29.7°C, during the entire growing season accompanied by adequate moisture supply. Asparagus spears are hardy and are seldom injured by cold winters. The crop should be protected from freezing.

Soil

Asparagus can be grown on nearly all kinds of soils, but deep soils preferably 2.4 m or more, well drained and friable to accommodate the plant's extensive root system.

Whereas clay soils, with poor permeability, should be avoided. For heavy yields the soil should be well drained, deep and loose, such as sandy loams and soils with high organic matter. Poorly drained and wet soils should be avoided, similarly light sandy and gravely should also be avoided as they have low moisture holding capacities.

Varieties

Mary Washington: It is a well established variety, tolerant to rust, with good productivity and has wide adaptability and good market quality. It is the most widely planted variety.

Early Argenteuil: It is said to be earliest and under favorable conditions it may give cut from the beginning of April onwards.

Connover's Colossal: It is originally an American variety and is later, having slender pointed buds which on exposure to the full light soon lose their reddish colour and becomes a lighter green than other kinds.

Martha Washington: It is a later variety very similar to Mary Washington.

Manures and Fertilizers

FYM *(q/ha)*	**N (Urea)**	**P_2O_5 (DAP)**	**K_2O (MOP) *kg/ha***
50-75	75 (160)	35 (77)	35 (60)

Harvesting

The first cutting of spears usually starts from third season or after the completion of two full growing seasons. The green asparagus which is the greater portion of the crop, cut 2.5 - 5 cm below the surface of the soil. Asparagus is usually harvested every day during the main season, but if the weather is cold, every other day or even every third day and if it is very hot twice a day.

14.3 Lettuce (*Lactuca sativa*)

Lettuce is most often used for salads, although it is also seen in other kinds of food, such as soups, sandwiches and wraps and can also be grilled. Lettuce is a good source of vitamin A and potassium, as well as a minor source for several other vitamins and nutrients. Despite its beneficial properties, lettuce when contaminated is often a source of bacterial, viral and parasitic outbreaks in humans, including *E. coli* and *Salmonella*. In addition to its main use as a leafy green, it has also gathered religious and medicinal significance over centuries of human consumption.

Soil

Lettuce grows best in loose, nitrogen rich soils with a pH of between 6.0 and 6.8.

Climate

Heat generally prompts lettuce to bolt, with most varieties growing poorly above 24°C, cool temperatures prompt better performance, with 16 to 18°C being preferred and as low as 7°C being tolerated

Varieties

There are several types of lettuce, but three (leaf, head and cos or romaine) are the most common. There are seven main cultivar groups of lettuce, each including many varieties:

Leaf: Also known as loose leaf, cutting or bunching lettuce, this type has loosely bunched leaves and is the most widely planted. It is used mainly for salads. Romaine/**Cos**: Used mainly for salads and sandwiches, this type forms long, upright heads. This is the most often used lettuce in Caesar salads.

Crisp head: Better known as "iceberg" lettuce, the most popular lettuce in the US, this type is very heat-sensitive and was originally adapted for growth in the northern US. It ships well, but is low in flavor and nutritional content, being composed of even more water than other lettuce types.

Butter head: Also known as Boston or Bibb lettuce, this type is a head lettuce with a loose arrangement of leaves, known for its sweet flavor and tender texture.

Summer Crisp: Also called Batavian or French Crisp, this lettuce is midway between the crisp head and leaf types. These lettuces tend to be larger, bolt-resistant and well-flavored.

Harvesting and storage

After harvest, lettuce lasts the longest when kept at 0°C and 96 percent humidity. Lettuce quickly degrades when stored with fruit such as apples, pears and bananas that release the ripening agent ethylene gas. The high water content of lettuce (94.9 percent) creates problems when attempting to preserve the plant - it cannot be successfully frozen, canned or dried and must be eaten fresh.

14.4 Swiss chard (*Beta vulgaris* subsp. *cicla*)

Swiss chard is a leafy green vegetable often used in Mediterranean cooking. The leaves can be green or reddish in color like Bib Lettuce, chard stalks also vary in color. Chard has been bred to have highly nutritious leaves at the expense of the root (which is not as nutritious as the leaves). Chard is considered to be one of the healthiest vegetables available, and is a valuable addition to a healthy diet (like other green leafy vegetables). Chard has been around for centuries, but because of its similarity to beets it is difficult to determine the exact evolution of the different varieties of chard.

Sowing time

Clusters of chard seeds are usually sown between April and August, depending on the desired harvesting period.

Varieties

Varieties of chard include green forms, such as 'Lucullus' and 'Fordhook Giant', as well as

red-ribbed forms such as 'Ruby Chard' and 'Rhubarb Chard. The red-ribbed forms are very attractive in the garden, but as a rough general rule, the older green forms will tend to out-produce the colorful hybrids. 'Rainbow Chard' is a mix of other colored varieties that is often mistaken for a variety unto itself.

Harvesting and storage

Chard can be harvested while the leaves are young and tender, or after maturity when they are larger and have slightly tougher stems. Harvesting is a continuous process, as most species of chard produce three or more crops. Raw chard is extremely perishable.

14.5 Brussel's sprouts (*Brassica oleracea* var. *gemmifera*)

Brussels sprouts was grown possibly as early as the 13th century in Belgium. During the 16th century, it spread throughout the cooler parts of Northern Europe and later on to other parts of the globe. It becomes ready for harvest 90 to 180 days after planting. The edible sprouts grow like buds in helical patterns along the side of long, thick stalks of about 60 to 120 cm (24 to 47 in) in height, maturing over several weeks from the lower to the upper part of the stalk. Sprouts may be picked by hand into baskets, in which case several harvests are made of five to 15 sprouts at a time, or by cutting the entire stalk at once for processing, depending on variety. Each stalk can produce 1.1 to 1.4 kg, although the commercial yield is about 900 g per stalk.

Climate: Brussels sprouts grow in heat ranges of 7-24°C, with highest yields at 15-18°C.

Soil: Deep loamy soil is best suited but it can be grown in a wide range of soils. The pH of 5.0-6.5 is optimum.

Seed rate: 300-400 g /ha

Sowing time

Zone	Sowing	Transplanting
Subtropical	Sept.-Oct.	Oct.-Nov.
Intermediate low	Aug.-Sep.	Sept.-Oct.
Intermediate high	March-April	April-May

Spacing: 60 cm x 45 cm

Manures and Fertilizers

FYM *(t/ha)*	N (Urea)	P_2O_5 (DAP)	K_2O (MOP) *kg/ha*
25	120 (250.0)	60 (132.0)	60 (102.0)

The full dose of P and K and half N are applied at the time of transplanting and remaining half of N be applied as band dressing in two split doses, first one month after transplanting and second at the time of head initiation as band dressing.

Integrated Nutrient Management

Micronutrient requirement of Brussels sprouts is very high. Molybdenum and boron may be supplied by soil application or foliar sprays. Soils with a pH above 7 affect the availability of boron. In soil application 500 g ammonium molybdate and 10-15 kg borax/ha helps in controlling the deficiency. Weekly sprays of 1-2% urea 20 days after transplanting gives better growth and increase the yield. Three foliar sprays of 0.3% borax after 20, 35 and 50 days after transplanting is beneficial in increasing the yield and checking the browning disorder.

Irrigation

Watering is done immediately after transplanting. Brussels sprouts needs sufficient moisture in the soil for uniform and continuous growth of plants. Frequent irrigation at 10-15 days are given depending upon weather conditions. Dry condition adversely affects the quality and yield of shoots.

Intercultural operations

2-3 hand hoeing and weeding is recommended to break the surface crust for better aeration and water absorption. Earthing up the crops 35 days after transplanting and immediately 2nd hoeing/weeding and application of 2nd dose of nitrogen.

Harvesting and storage

Miniature cabbages are harvested periodically when the buds are still intact and shiny. After harvesting, these are cooled in ice cold water and are marketed in paper cartons. They should be cooled at 4°C and then packed with ice in crates. They can be stored well for 7-10 days at 4°C.

15. Nursery Management in Winter Vegetables

The vegetable crops propagated by seeds, like cucurbits, beans, radish, turnip, leafy vegetables and okra are required to be sown directly in the field whereas crops like tomato, brinjal, chillies, cabbage, cauliflower, knol-khol, brussle's sprout, broccoli and onion etc. are first sown in the nurseries for raising seedlings and then transplanted. The site of nursery should be close to water source.

A nursery has the following advantages:

- It is very convenient to look after the tender seedlings.
- Timely and careful plant protection measures are possible.
- Most favourable growth medium is provided.
- Seedlings are in a protected place and usually timed for early crop.
- There is economy of land and seed.
- More time is available for field preparation.

Soil

The soil should be well drained, fertile and rich in organic matter so as to provide better germination and excellent medium for seedling growth. Enough of well rotten farm yard manure should be mixed thoroughly in the soil. The size of nursery bed should be small, usually of dimensions of 1 m x 1 m, 1.25 m x 1 m or 2 m x 1 m as this size facilitates weeding and watering without trampling the seed bed. The bed is usually kept raised (about 15 cm high) so as to provide proper drainage of excess water.

Sowing

The seeds are sown in nursery beds. Line sowing in beds should be preferred so as to ensure proper germination and facilitate weeding, hoeing and plant protection operations. The rows should be kept 5 cm apart. The seed is usually sown 0.5 cm deep and 2.0 to 4.0cm apart. The size of nursery bed to raise seedling to plant a hectare of cole crops like cabbage, cauliflower and knolkhol etc. should be 25 sqmts. This can be made into smaller beds instead of making a single bed. Small sized seeds should be sown mixed with a little sand and then covered with soil. The covering of the seeds in furrow or row may be done gently by fingers or with the aid of a wooden strip, followed by a light irrigation with a sprinkler.

After care

Watering of the bed should be done uniformly and gently so as to avoid a packing of the soil. In the beginning, the mid day sun may be avoided by covering the seedlings with a thin layer of leaves or thatch. During summer, the seedlings may be protected against warm wind and sunshine. Proper weeding should be done and insect-pests and diseases should be kept under Control measures. Two to three sprays of Chlorpyriphos (1 ml per litre) + Mancozeb (2g per litre) in nursery are essential. A week before transplanting, the seedlings may be exposed to full sunshine and the number of watering reduced so that the seedlings become hardy to bear the shock of transplanting.

Transplanting

The seedlings should not be allowed to grow very tall. Transplanting should be done as soon as seedlings are about 4-8 week old *(10-15* cm in length and have formed the leaves). The bed must be watered a few hours before uprooting the seedlings for transplanting. The transplanting should always be done in the afternoon so that plants may get established in the cool weather at night and may recover from the shock of transplanting before the sunrise. Regular watering is necessary after transplanting. Seedlings not doing well may be replaced by new ones. During transplanting, care should be taken to protect the seedlings against wilting by frequently sprinkling water on them and by covering the root zone by moist sailor leaves.

Damping off and its management in nursery

Damping off is considered as destructive disease responsible for poor germination and poor stand of seedling in nursery beds. The disease may be physiogenic (caused by disorders) or pathogenic (caused by micro-organisms mostly fungi). Of the various fungi reported to be responsible for damping off of seedling, species of Pythium are more common than others. The pathogen survives in soil and cause infection to the seedlings of vegetables like brinjal, chillies, tomato cabbage, cauliflower, knol-khol and many other if and when predisposing conditions like excessive soil moisture or lack of proper drainage, thick population of seedling in the nurseries and excessive nitrogen are there.

The disease occurs in two stages viz., pre-emergence phase and post emergence phase. In the pre-emergence phase, seed rot or damage to the just germinating seedlings occurs with the result either the seeds fail to germinate or young seedlings are killed before they reach the surface of the soil. The post-emergence phase is conspicuous and is characterized by the toppling over of infected seedlings. Infection usually occurs at and below the ground level and the infected tissues appear soft and water soaked. As the disease advances, the stem becomes constricted at the base and the plants collapse. The maximum damage is due to the pre-emergence phase and is often not recognized, since damage occurs under soil surface.

Control measures

- Seed treatment with Mancozeb, Thiram or Captafol @lg/kg of seed.
- Soil drenching of the nursery beds 5 to 7 days before seeding with Thiram (150 gm in 100 *l* of water) or Zineb, Mancozeb (300 g in 100 *l* of water). Apply 51itre of suspension per square metre area.
- Foliar applications of Mancozeb(250 g in 100 litre of water) to reduce the post emergence incidence.

In addition to the above mentioned chemical control measures, following precautions should also be observed to minimise the disease incidence:

- Thin sowing to avoid over crowding
- Soil should be light and well drained
- Nursery bed should be raised to maintain good drainage.
- Avoid excessive use of nitrogen

16. Protected Cultivation of Vegetables

In the present scenario of perpetual demand for better quality vegetables and continuously shrinking land holdings, protected cultivation is the best choice for quality produce and efficient use of land and other resources. Protected cultivation means some level of Control measures over plant microclimate to alleviate one or more of abiotic stress for optimum plant growth which can be achieved in poly house or net house. Crop yields can be several times higher than those under open field conditions, quality of produce is superior, higher input use efficiencies are achieved and vegetable export can be enhanced. In Jammu, extreme weather conditions under the open field conditions are the major limiting factors for achieving higher yields and better quality of vegetables. Under such circumstances, protected cultivation is best option. Keeping these points in view, net house and poly house technology has been recommended for the cultivation of different vegetables.

Types of protected structures

- **Hi-Tech or fully climate Controlled or high cost green house**

This type of green house is constructed to achieve higher degree of climate Control measures to enhance the cultivation period of the crop. The temperature, humidity and light are automatically controlled. These green houses are mostly used for cultivation of tomato and sweet pepper over a longer period of time.

- **Partial climate Controlled or medium cost green house**

The structural frame is made up of galvanized iron pipes, like the climate Controlled green house, but only the exhaust fans with evaporate cooling pads are provided to maintain the favorable temperature and humidity during summer.

- **Naturally ventilated or low cost green house**

These are simple green houses with low initial investment. The frame may be galvanized iron pipes, bamboos, wooden logs or steel pipes, or any other local material but no heating or cooling system are provided for the structure. The initial cost of these greenhouses is less than half to that of semi climate Controlled greenhouses. Low cost green house can be constructed to raise the vegetables and flower crops almost round the year and off-season thereby providing enough opportunities to the poly house growers to fetch early and remunerative price of the quality produce.

- **Plastic low tunnels**

Plastic low tunnels or row covers are simple and low cost structures for off-season production of vegetable crops in open fields. The soil temperature is also raised and the plants are also protected from hail, winter cold injury, frost and strong winds etc.

Nursery technology for protected cultivation

Improved hi-tech methods of nursery raising have been standardized for healthy disease free and off-season vegetable nursery such as

i. Polythene bags

ii. Plug tray nursery production

iii. Portable low plastic tunnels technology

Growing media used for nursery production

a. Coco-peat: Coco peat also known as coir pith, coir fiber pith and coir dust. Coco peat is relatively new growing medium available these days for the hydroponics and soil less culture. Coco coir is being produced as a byproduct of the coconut tree. Coco peat is a proven best alternative to any growing media. Its use as a growing medium out performs any other medium used for growing vegetables, ornamentals and tree plants. Coco coir is 100% environmentally friendly.

b. Perlite: Perlite is a siliceous mineral of volcanic origin. The grades used in alternate media are first crushed and then heated until the evaporation of combined water expands it to a light powdery substance. It is neutral in reaction and provides no nutrients to the mix except for small amounts of sodium and aluminum.

17. Trench Cultivation of Vegetables Crops

River bed vegetable production in trenches is a very old practice of growing vegetables on the basins of the rivers where the capillary rise is known to be major source of meeting the water requirement of crops under shallow water table conditions. In India trench cultivation is being practiced in Lalsoot area of Rajasthan, on the banks of river Yamuna in Delhi, Balachour and Macchiwara area of Punjab, Una district of Himachal Pradesh and on the banks of river Tawi and Chenab in Jammu area of J&K. Of late refinement in trench geometry, orientation of trenches, angles of wind breakers and standardization of IPM and INM modules under irrigated and un irrigated conditions in commercially important vegetables on the perennial river beds under intense cold weather conditions has extended its cultivation where different vegetables completes their life cycle efficiently utilizing the ground water through capillary action.

River beds are formed by alluvian and diluvian action of rivers and due to induction caused by swollen rivers during South West monsoon. Fresh clay and silt deposited every year during monsoon months make the land suitable for growing vegetables literally on sandy silt soils where vast tracks of riverbeds are dry and fallow during the period from mid September to July before the onset of rainy season. Even though the upper layer of sand seems unsuitable for cultivation, subterranean moisture seeped from adjacent river streams make it possible to grow early crops. Cucurbits and Solanaceous vegetables are well adapted to this situation due to long tap root system There is a wide potential to bring more un-exploited fallow lands under this specialized type of vegetable farming by way of dissemination of production technology on various aspects of trench cultivation of vegetables to the farmers through trainings and on farm demonstrations.

Trench digging / preparation of trenches

Trench cultivation is a specialized technique of growing off season summer vegetables under

intense cold conditions through vegetable forcing techniques. Vegetables mostly cucurbits and solanaceous vegetables are sown from mid September-December in trenches for production of peri urban summer vegetables. Though it is mostly practiced on the banks of perennial nullahs free from industrialist effluents and heavy metals and rivers yet this type of cultivation has been extended on other farming lands rich in organic carbons and manures. Land is demarcated for the digging of trenches after the rains are over by 1st week of September. It is always best to dig the soil when it is reasonably moist because it would not change the soil texture, particularly when dealing with the soil that has a high proportion of clay.

Trenches are demarcated and dug manually or by mechanical methods in East-West direction for better sunlight from southern side. Length of the trench is kept 30-35 m, width 1.0-1.25m and depth 1.75-2.0m depending on the area and height of the water table of that particular area. These trenches are dug up to the level from where the ground water starts oozing which is the principle of river bed / trench cultivation in the areas where irrigation facilities are not available so, that the crop may fulfill its water requirement during summer months from the ground through capillary action. In irrigated areas trenches are dug up to the depth of 0.75-1.00m below the ground level. Trenches are generally spaced 2.0- 3.0 meters apart depending upon the variety and type of crop to be raised.

Trench filling and trench geometry at sowing

Trenches are filled with mixture of soil, sand, well rotten FYM and organic manures up to 0.5 feet below ground level to act as hot beds in such a way that these may go down to the root zone for better growth of the crop during intense cold conditions. After filling the trenches are left for few days to settle various layers of soil. Sometimes pre sowing irrigation is also managed which not only settle the soil layers but also facilitates better germination of seed.

Manures and fertilizers

Since the sandy clay soil is rich in humus carried from forests, during rainy season, very less quantity of manures and fertilizers are required. Fertilizers are applied away from the plants in shallow side trenches. However, manure and fertilizers per trench at the following rates are recommended to improve the soil structure and water holding capacity of the soil for better growth, yield and quality of vegetable crops.

Manures and Fertilizers

FYM	Urea	DAP	MOP (*kg/trench)*
250	2.0	3.0	1.0

Bio-fertilizers like *Azotobacter* and *Azospirillium* @ 5g/m^2 and *Trichoderma* @ 2-3 kg/ trench are advisable which takes care of all soil borne root pathogens to protect the crops from collar rot, damping off and wilt disease. Organic manures shall be incorporated in trenches few weeks earlier to sowing and plantings.

Pre- sprouting of seeds

Seeds are dipped in a water container for 4-6 hours. Rinse the seeds properly and wrap the moist seeds in a bundle of straw and leaves in a piece of cloth. Keep the tightly wrapped bundles containing seed in a heap of FYM or at a warmer place for two days to fasten its sprouting. Keep the sprouted seeds in a tightly packed polythene bag for it further use till the sowing is completed in the field.

Sowing/ transplanting time

Generally pre sprouted seeds of cucurbits @ of two seeds per hill are sown under optimum soil moisture conditions to facilitate maximum seed germination. The seeds are sown at a depth of 3-4 cm and at a spacing of 60 cm. Immediately after sowing trenches are covered with low density polythene sheets of convenient length and width to conserve heat till the seed germinates and thereafter, the young seedlings are protected from intense cold waves and frost by installing mulberry twigs arc tunnels covered with polythene sheets throughout the winter season.

Bitter gourd	:	Ist fortnight of September
Pumpkin	:	Ist fortnight of October
Bottle gourd	:	Ist fortnight of November
Round Gourd	:	Ist fortnight of November
Summer Squash	:	Ist fortnight of November
Cucumber	:	Ist fortnight of January
Muskmelon	:	Ist fortnight of January
Watermelon	:	Ist fortnight of January
Watermelon (Autumn)	:	Last week of October

Transplanting of seedlings raised in poly-bags/ low cost poly arc tunnels is also recommended to save time for raising of early crop to fetch remunerative returns.

After few weeks, root system develops and starts exploiting nutrients and moisture through capillary action for growth and spreading of vines. Top dressing of urea @ 2.0 kg per trench is applied followed by hoeing and weeding. Care should be taken that the urea should not come in direct contact with the plants particularly under un-irrigated conditions where damage to the spreading vines has often noticed. Periodical sowings of cucurbits at an interval of 7 days to regulate the supply of fruits in the market is recommended as per the schedule mentioned below:

40 days old seedlings of tomato, brinjal and capsicum raised under low cost poly arc tunnels/ thatch houses during intense cold conditions of December can also be transplanted in the month of January in trenches for production of early crops.

Irrigation

Initially the young seedlings for their establishment are watered with fountain bucket and there after roots extend to exploit nutrients and moisture from below the trenches through capillary action where surface water is not available. Under irrigated conditions irrigation is applied as per the requirement of the crop. It is always advisable to apply light irrigation to the trench growing crops to avoid damage to the crops by anoxia or hypoxia conditions

Orientation of wind breakers

In Northern India where winter temperature dips down to 1°C during December and January, the young plants are protected against frost and wind by erecting wind breakers of *Saccharum munja* at an angle of about 60° to the trench across to facilitate cultural practices, protection from cold waves and frost. It has following uses:

a) Checks sand drifting on the dug up trenches and covering the hills sown with seed
b) Provides protection from chilly winds and frost
c) Wind breaker grass is spread over the sand for training of vines.

d) Prevent the sand being blown off with vines especially in May when too hot summer winds sweep the areas

e) Protect fruits from heat and fruit rot.

Training of vines

After proper hoeing and weeding, top-dressing and earthing up of the plants, training of spreading vines is of utmost importance. The sarkanda grass which has already served as wind breakers during winter months is spread on the mounts of trenches for training and spreading of vines. This also helps to protect the fruits from rotting by soil borne pathogens.

Harvesting and yield

The harvesting of crop is done at proper maturity stage and sent to the market after proper packaging. The yield is variable depending upon the location. The crop fetches lucrative returns because of its early marketing than the conventional vegetable production in the open fields.

Cost: Benefit Ratio

Average net profit of Rs 10,000 to 15,000/-per kanal/crop is earned with a cost benefit ratio of 1:5.

18. Utilization of Hybrid Vigour in Vegetables

The supremacy of hybrids has been demonstrated in various vegetables all over India and is on the verge of a breakthrough in establishing hybrids on a commercial scale for enhancing the production of vegetables. There had been many reports of manifestation of heterosis in various vegetables like tomato, brinjal, capsicum, okra, bottle gourd, water melon, bittergourd, cabbage, radish, cucumber, pumpkin, onion etc. The secret of success of F1 hybrids lies in the fact that all plants are exceptionally uniform in growth and development, resistant to many diseases and insect-pests, better adaptable to changing and adverse ecological conditions and above all gives high early as well as total yields. Multiple resistance to diseases and insects-pests when it is Controlled by dominant genes can be directly availed in Fl hybrids.

Heterosis in vegetable crops is manifested in different ways like:

- High yield: Due to large size and weight of fruit, bulbs or heads (Cabbage, watermelon, onion, pumpkin and squash) and/or due to increased number of fruits mainly as a result of early fruiting (tomato, brinjal, cucumber, pumpkin, squash and okra).
- Uniformity in size: Onion and cabbage
- Uniformity in maturity: Onion
- Early maturity: Cabbage, watermelon, muskmelon, Onion, tomato, brinjal etc.
- Large number of marketable heads or bulbs per unit area: Cabbage and onion.
- Better resistance to diseases: Spinach, cucumber, tomato and watermelon.
- Better resistance to insect pest: Onion.
- Better resistance to drought: Watermelon
- Better fruit quality: Tomato, Watermelon.
- Better flavour, higher proportion of flesh and more sugar: muskmelon

Seeds of Fl hybrids like in Tomato, Capsicum, Bottlegourd, Brinjal and many other vegetables are now available. But the demand for hybrid seeds is increasing even though cost of seed is more. This is because the vegetable growers as well as the consumers are now realizing that the productivity per unit area of hybrid vegetables is more as compared to normally grown vegetables along with good quality. The hybrids are assuming more importance these days in Kitchen gardening and container gardening. Hybrids have great potential in this State for boosting up vegetable production and consumption. These hybrids may give specific performance in various microclimates under different agro-climatic situations.

Useful tips for hybrid vegetables

- Obtain seeds from authentic/ reliable source (preferably public sector institutions)
- Seed rate is generally half or even less of the recommended rate for varieties.
- Dose of nitrogenous fertilizer is usually increased and often split in 3 split doses
- Grow hybrids only in situations where irrigation is assured and plant protection measures are within reach of farmers or affordable.
- It is advisable to use high yielding multi-disease resistant hybrids.

19. Multiple Cropping in Vegetable Crops

Most of the vegetable crops are of short duration and fit in with a number of sequences which results in greater production per unit area and time. Adoption of multiple cropping in vegetables enhances the income of the farmer. It also helps in weed control measures. The success of these vegetable rotations depends upon the selection of proper crops and varieties, adjustment of sowing time, adequate application of organic manures and fertilizers, irrigation, Control measures of weeds, insect pests and diseases and timely harvesting. The timeliness of these cultural operations becomes a critical factor in a successful multiple cropping programme.

Viable and Sustainable vegetable based cropping systems for different zones Sub-tropical zone

1.	**Tomato** (End Jan.-End May) January)	**Brinjal** (June- November)	**Cole crops** (December-
2.	**Brinjal**	**Sweet corn** (May- Sept)	**Potato** (Oct- End Jan)
3.	**Onion**	**Brinjal**	**Radish**
4.	**Cucumber**	**Brinjal**	**Knol Khol**
5.	**Gourds**	**Okra**	**Potato**
6.	**Potato**	**Sweet Corn/Okra**	**Radish**
7.	**Pumpkins/Squashes**	**Brinjal**	**Cauliflower**
8.	**Okra** (End Jan- June)	**Cucumber** (July-Oct)	**Potato** (Oct- Jan)
9.	**Beans**	**Okra**	**Leafy**
	Vegetables		
	(Mid Jan-May)	(June- Oct)	(Nov- Jan)

Tomato & Spring Potato based cropping systems are highly vulnerable to temperature fluctuations. Adherence to the recommended planting dates and stable varieties is strictly recommended to meet the vagaries of climate change for potential harvests.

Intermediate higher Zone

April-July: Tomato, potato, capsicum spp. brinjal, beans, cabbage, cauliflower, knol khol, kale, cucurbits and beans.

August- October: Leafy Vegetables, radish, turnip and beans.

October-May: Garlic, peas, potato and asparagus are hard winter season crops and resist under snow and perform well under sub zero temperature and low precipitation conditions. Potato and peas sprout after the melting of snow, growth of garlic is restricted and asparagus remains dormant under cool conditions.

Lively hood security for different segments of farming community

Dry land vegetable production on the river banks

- Production of off-season/ early vegetables on the barren sandy banks of perennial rivers like Tawi, Chenab and Basantar by utilizing sub surface water through trench techniques
- **October- June:** Production of melons, gourds, pumpkin & squashes and tomato, capsicum and brinjal
- **July-October:** Okra, brinjal, cucumber and bottlegourd

Dry land vegetable production under low Shivalik hill conditions

- **Rainy season:** Transplanting of tomato and cultivation of cucumber and gourds with the on set of pre monsoon rains and their training on the bamboo knitted structures, cowpea mixed cropping with maize and trailing of vines on maize crop.
- **Winter season:** Production of minimum water required cool season crops like radish, garlic and onion and water required at critical stages is often fulfilled by local rains.

Farming Community with small land holdings

Adopt production of quality planting material on commercial scale under protected structures

- November -December nursery sowing to meet early demands of sub tropical zone
- January- February nursery sowing to meet intermediate lower zone demands
- February- March nursery sowing to meet intermediate higher zone demands
- May- June nursery sowings under shade net houses for production of rainy season seedlings
- September -November nursery sowings to meet intermediate higher zone demands

Annexure I (A)

Area under vegetables in Jammu division during Kharif- 2014 (in Hectare)

S. No.	Vegetable Crops	Jammu	Samba	Kathua	Udham-pur	Ramban	Reasi	Doda	Kishtwar	Rajouri	Poonch	Area (in Hectare)
		Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	
1	Bhindi	1000	216	250	225	40	155	140	40	175	160	2401
2	Tomato	480	63	100	370	100	130	180	30	135	140	1728
3	Brinjal	380	24	80	50	44	65	110	30	195	90	1068
4	Chillies	100	50	50	40	50	80	90	40	255	80	835
5	Capsicum	50	10	10	50	10	5	0	30	25	25	215
6	French beans	200	37	75	50	20	80	200	50	133	140	985
7	Cucumber	180	16	60	40	32	35	80	30	119	90	682
8	Bottle-gourd	180	23	100	40	10	40	61	30	120	60	664
9	Bitter Gourd	70	20	40	15	5	30	35	20	90	40	365
10	Water melon	200	20	35	7	0	4	10	0	0	0	276
11	Musk melon	75	15	20	5	0	2	0	0	0	0	117
12	Pumpkin	50	14	40	30	13	17	20	40	78	10	312
13	Ginger	160	0	10	120	0	0	5	30	0	0	325
14	Turmeric	170	0	30	100	0	0	5	30	0	0	335
15	Tinda	40	10	10	15	0	0	10	0	0	0	85
16	Onion	0	0	30	90	0	0	0	0	0	105	225
17	Knol-khol	0	0	40	103	12	0	110	0	0	0	265
18	Potato	0	0	40	210	112	0	100	15	0	102	579
19	Radish	0	86	0	0	0	0	0	0	0	75	161
20	Sponge Gourd	0	15	0	0	0	4	0	0	0	0	19
21	Cabbage	0	00	0	0	0	0	0	0	0	53	53
22	Carrot	0	0	0	0	0	0	0	0	0	15	15
23	Cauliflower	0	0	0	0	0	0	0	0	0	55	55
24	Peas	0	0	0	0	0	0	0	0	0	70	70
25	Parwal/ Pointed gourd	0	0	0	0	0	5	0	0	0	0	5
26	Others	40	0	80	40	0	0	0	05	0	0	165
	TOTAL	**3375**	**619**	**1100**	**1600**	**448**	**652**	**1156**	**420**	**1325**	**1310**	**12005**

Production of vegetables in Jammu division during Kharif- 2014 (in M. tons)

S. No	Vegetable Crops	Jammu	Samba	Kathua	Udhampur	Ramban	Reasi	Doda	Kishtwar	Rajouri	Poonch	Production (in Mts.) Total
		Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	
1	Bhindi	20000	6048	5200	3484.05	290	610	1890	146	1925	3203	42796.05
2	Tomato	14400	1764	2560	9356.95	2700	1540	2430	570	2160	3041	40521.95
3	Brinjal	9310	552	1760	924.41	450	1168	1485	498	2925	1160	20732.41
4	Chillies	1900	750	355	1021.94	450	510	1215	240	2295	1543	10279.94
5	Capsicum	275	35	55	675.72	201	40	0	12	100	335	1728.72
6	French beans	2700	407	862.50	1021.94	200	544	2700	405	931	3050	12821.44
7	Cucumber	4680	208	762	1540.69	480	299	1120	202	1071	1651	12013.69
8	Bottle-gourd	5400	437	2050	1367.25	200	354	823.5	510	1920	1108	14169.75
9	Bitter Gourd	1400	350	324	965.91	95	233	472.5	103	1080	552	5575.41
10	Water melon	5600	800	1708	216.26	0	20	137	0	0	0	8481.26
11	Musk melon	1275	330	300	78.25	0	10	0	0	0	0	1993.25
12	Pumpkin	1250	392	1140	419.61	370	125	270	805	1404	165	6340.61
13	Ginger	1600	0	174	2185.32	0	0	67.5	209	0	0	4235.82
14	Turmeric	2295	0	579	309.75	0	0	68.5	513	0	0	3765.25
15	Tinda	620	152	85	885.40	0	0	135	0	0	0	1877.4
16	Onion	0	0	435	1295.85	0	0	0	0	0	1597	3327.85
17	Knol-khol	0	0	644	2274.65	170	0	1485	0	0	0	4573.65
18	Potato	0	0	980	4698.28	3300	0	1350	310	0	355	10993.28
19	Radish	0	2752	0	0	0	0	0	0	0	1381	4133
20	Sponge Gourd	0	173	0	0	0	20	0	0	0	0	193
21	Peas	0	0	0	0	0	0	0	0	0	1216	1216
22	Cauliflower	0	0	0	0	0	0	0	0	0	997	997
23	Cabbage	0	0	0	0	0	0	0	0	0	883	883
24	Carrot	0	0	0	0	0	0	0	0	0	198	198
25	Parwar/ Pointed gourd	0	0	0	0	0	20	0	0	0	0	20
26	Others	880	0	2440	2303.48	0	0	0	30	0	0	5653.48
	TOTAL	**73585**	**15150**	**22413.5**	**35025.71**	**8906**	**5493**	**15649**	**4553**	**15811**	**22935**	**219521.21**

Annexure I (B)

Area under vegetables in Jammu division during Rabi -2014-15 (in Hectare)

S. No.	Vegetables Crops	Jammu	Samba	Kathua	Udhampur	Ramban	Reasi	Doda	Rajouri	Poonch	Kishtwar	Area (in Hectare)
		Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	
1	Knol-khol	900	128	120	100	75	43	340	205	0	50	1961
2	Cauliflower	1000	165	150	200	45	45	150	95	56	30	1936
3	Cabbage	900	66	120	150	45	43	120	90	55	30	1619
4	Kale/Hak Saag	0	0	5	30	30	0	70	0	0	25	160
5	Radish	500	210	110	90	44	55	280	235	77	50	1651
6	Turnip	100	43	50	75	12	50	40	210	0	35	615
7	Carrot	110	125	60	30	5	25	20	45	16	15	451
8	Spinach	260	52	40	35	50	35	70	0	0	15	557
9	Methi	170	5	30	30	3	25	40	0	0	20	323
10	Onion	500	180	235	180	110	50	236	125	107	60	1783
11	Garlic	100	25	50	100	8	0	80	110	0	25	498
12	Peas	200	134	150	250	106	45	320	210	72	120	1607
13	Potato	1940	87	450	120	19	120	25	210	104	0	3075
14	Coriander	0	10	15	30	0	5	50	0	0	11	121
15	Tomato	0	33	0	0	0	0	0	0	142	0	175
16	Brinjal	0	0	0	0	0	0	0	0	92	0	92
17	Beans	0	0	0	0	0	0	0	0	142	0	142
18	Bitter Gourd	0	0	0	0	0	0	0	0	41	0	41
19	Bottle Gourd	0	0	0	0	0	0	0	0	62	0	62
20	Capsicum	0	0	0	0	0	0	0	0	27	0	27
21	Chilli	0	0	0	0	0	0	0	0	82	0	82
22	Bhindi	0	0	0	0	0	0	0	0	160	0	160
23	Pumpkin	0	0	0	0	0	0	0	0	12	0	12
24	Cucumber	0	0	0	0	0	0	0	0	92	0	92
25	Others	20	0	35	180	0	0	0	0	0	50	285
	TOTAL	**6700**	**1263**	**1620**	**1600**	**552**	**541**	**1841**	**1535**	**1339**	**536**	**17527**

Production of vegetables in Jammu division during Rabi -2014-15 (in M. tones)

S. No.	Vegetables Crops	Jammu	Samba	Kathua	Udhampur	Ramban	Reasi	Doda	Kishtwar	Rajouri	Poonch	Production (in Mts.)
		Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	Prod (Mts)	
1	Knol-khol	18900	2304	2472	3322.64	1100	829	4590	4100	0	480	38097.64
2	Cauliflower	35000	4785	3600	4438.84	900	930	2025	1900	1096	303	54977.84
3	Cabbage	31500	1914	2940	2407.28	1075	829	1620	1890	971	290	45436.28
4	Kale/Hak Saag	0	0	30	298.95	09.00	0	945	0	0	122	1404.95
5	Radish	15000	6300	3465	2014.68	748	759	3780	4935	1519	698	39218.68
6	Turnip	2500	1290	1510	1895.34	214	435	540	4620	0	702	13706.34
7	Carrot	990	3875	1800	766.94	244	270	270	810	217	32	9274.94
8	Spinach	3640	1040	324	402.27	376	299	952	0	0	88	7121.27
9	Methi	1360	63	1458	898.04	20.00	270	544	0	0	70	4683.04
10	Onion	15000	4320	4700	2517.45	201.00	435	3186	2500	1756	1195	35810.45
11	Garlic	800	550	675	2354.18	08.00	0	1080	2200	0	301	7968.18
12	Peas	2400	3350	3000	4711.91	870.00	461	1920	3360	1337	710	22119.91
13	Potato	50440	2610	11475	3087.98	720	2568	350	5250	390	0	76890.98
14	Coriander	0	120	52.50	1504.80	0	20	680	0	0	4	2381.3
15	Tomato	0	858	0	0	0	0	0	0	3345	0	4203
16	Beans	0	0	0	0	0	0	0	0	3355	0	3355
17	Bitter Gourd	0	0	0	0	0	0	0	0	607	0	607
18	Bottle Gourd	0	0	0	0	0	0	0	0	1218	0	1218
19	Brinjal	0	0	0	0	0	0	0	0	1826	0	1826
20	Capsicum	0	0	0	0	0	0	0	0	368	0	368
21	Cucumber	0	0	0	0	0	0	0	0	1815	0	1815
22	Chilli	0	0	0	0	0	0	0	0	1697	0	1697
23	Bhindi	0	0	0	0	0	0	0	0	3523	0	3523
24	Pumpkin	0	0	0	0	0	0	0	0	181	0	181
25	Others	460	0	703.50	7359.35	0	0	0	0	0	480	9002.85
	TOTAL	**177990**	**33379**	**38205**	**37980.65**	**6485**	**8105**	**22482**	**31565**	**25221**	**5475**	**386887.65**

Source: Agronomist (Vegs.)

Talab Tillo, Jammu

Annexure II

Minimum limit of seed standards in respect of different kinds of seeds specified by Ministry of Agriculture, New Delhi in exercise of power conferred by clause (a) of section of the Seed Act 54 of 1966

S. No.	Kind of Seed	Minimum limit of germination per cent	Minimum limit of purity per cent	Maximum other crop seeds/kg		Maximum number of weed seeds/kg		Maximum limit of moisture%	
				F	C	F	C	Maximum	Vapour Proof Containers
1.	Asparagus	70	96	05	10	05	10	08	06
2.	Amranths	70	95	05	10	10	20	08	06
3.	Ash Gourd	60	98	None	None	None	None	07	06
4.	Bhindi	65	99	None	05	None	None	10	08
5.	Bittergourd + hybrids	60	98	None	None	None	None	07	06
6.	Bottlegourd + hybrids	60	98	None	None	None	None	07	06
7.	Brinjal	70	98	None	None	None	None	08	06
8.	Broccoli	65	98	05	10	05	10	07	05
9.	Cowpea	75	98	None	10	None	10	09	08
10.	Cucumber + hybrids	60	98	05	10	None	None	07	06
11.	Cauliflower	70	98	05	10	05	10	07	05
12.	Cabbage	70	98	05	10	05	10	07	05
13.	Chinese Cabbage	70	98	05	10	05	10	07	05
14.	Cole crops (hybrids) + Broccoli	70	98	None	None	None	None	07	05
15.	Carrot	60	98	05	10	05	10	08	07
16.	Chilli	60	98	05	10	05	10	08	06
17.	Capsicum	60	98	05	10	05	10	08	06
18.	Celery	70	97	05	10	05	10	08	07
19.	Coriander	65	95	-	-	-	-	-	-
20.	French bean	75	98	None	None	None	10	09	07
21.	Garlic	90	95	xx	xx	xx	xx	xx	xx
22.	Ginger(Rhizome)	90	95	-	-	-	-	-	-
23.	Knolkhol	70	98	05	10	05	10	07	05
24.	Lettuce	70	98	None	None	05	10	08	06
25.	Muskmelon + hybrids	60	98	05	15	None	None	07	06
26.	Methi Kasuri (Fenugreek)	70	98	10	20	10	20	08	06
27.	Onion	70	98	05	10	05	10	08	06
28.	Peas	75	98	None	05	None	None	09	08
29.	Pumpkin	60	98	None	None	None	None	07	06
30.	Seed potato	80/90	98/95	-	-	-	-	12	-
31.	Parsley	65	97	05	10	05	10	08	07
32.	Radish	70	98	05	10	10	20	06	05
33.	Radish hybrids	70	98	None	None	None	None	06	05
34.	Summer Squash	60	98	None	None	None	None	07	06
35.	Spinach	60	96	05	10	05	10	09	08
36.	Sponge gourd	60	98	None	None	None	None	07	06
37.	Sugar beet	60	96	05	10	05	10	09	08
38.	Taro (Arbi) Colocasia	90	95	-	-	-	-	08	-
39.	Turnip	70	98	05	10	05	10	06	05
40.	Turnip hybrids	70	98	None	None	None	None	06	05
41.	Tinda (Indian squash)	60	98	None	None	None	None	07	06
42.	Tomato	70	98	05	10	None	None	08	06
43.	True potato seed hybrid (TPS)	80	98	-	-	10	-	08	06
44.	Winter squash	60	98	None	None	None	None	07	06
45.	Watermelon	60	98	None	None	None	None	07	06

Annexure III

First Aid Measures

Re-assurance and complete rest to the victim to retard the absorption of venom. A wide tourniquet (or any piece of cloth) should be placed a few centimeters above the site of bite. It should be tight to an extent that a finger should pass below it with difficulty. Suction of venom should be done by giving a 1 cm linear and ½ cm deep incision at the mark of the fangs after applying an antiseptic lotion. Suction should preferably be done with rubber bulb, breast pumb or with mouth after ensuring that there is no oral lesion. It should be continued for about an hour. If done promptly 50% of the venom can be removed.

A) Cut injury

- The first aid treatment of cut injury depends upon the date and extent of injury. But in first aid one should clean the wound with antiseptic lotion
- If it is bleeding profusely tight bandage without ointment is to be given
- The injured part should be kept raised or elevated.
- If there is any associated fracture, a proper split or support should be given. But the patient, should be brought to the hospital at the earliest possible.

B) Snake bite oreventions

In snake infested regions long trousers, high shoes or leggings and gloves should be worn. Most important is to where one steps while walking.

C) Electric injuries-preventions

- Education of electric hazards to everybody.
- Proper installation of electric appliances, grounding of telephone lines, radio and television arials, use of rubber gloves and dry shoes when working with electric circuits.

Prompt switching off the current, if possible. Immediate removal of the victim from the contact with the current without directly touching him. Rescurer should use a rubber sheet, a leather belt, a wooden pole or any other non conductive material to detach him.

Honey bee and wasp bites

- Cooling of the part with ice pads.
- Removal of stings.
- Cleaning with soap and water.
- Local and systemic anti allergics to be given.
- Perfumes and bright colours attract these insects and should be avoided.
- Sensitive person can have severe anaphyllatic shock with even a single bite.
- Every such patient must get the medical aid from a doctor.

Precautions

In case of pesticide poisoning, call a physician immediately. Awaiting the physician's arrival, apply the **FIRST AID**.

1. **Swallowed Poisons**
   - Remove poison from the patient's stomach immediately by inducing vomiting. Give common salt one tea-spoonful (15 g) in a glass of warm water (emetic) and repeat until the vomut fluid is clear. Gentle stroking or touching the throat with a finger or placing the blunt end of a spoon will help induce vomiting when the stomach is full of fluid.
   - If the patient is already vomiting, do not give common salt in warm water and follow the specific directions as suggested**.**

2. **Inhaled Poisons**
   - Carry the patient (do not let him walk) to fresh air immediately.
   - Open all doors and windows.
   - Loosen all tight clothing.
   - Apply artificial respiration if breathing has stopped or is irregular. Avoid a vigorous application of pressure to the chest.
   - Cover the patient with a blanket.
   - Keep the patient as quite as possible.
   - If the patient is convulsing, keep him in bed in some dark room.
   - Avoid any jarring noise.

3. **Skin Contamination**
   - Drench the skin with water (giving a shower with a hose or pump).
   - Apply a stream of water to the skin while removing the clothing.
   - Clean the skin thoroughly with water.
   - Rapid washing is most important for reducing the extent of injury.

4. **Prevention of Collapse**
   - Cover the patient with a light blanket.
   - Do not use a hot-water bottle.
   - Raise the feet of the patient on the bed.
   - Apply elastic bands to arms and legs.
   - Give strong tea or coffee.
   - Give hypodermic injection of stimultants, such as caffine and epinephrine.
   - Give blood or plasma transfusion.
   - Do not exhaust the patient by too much or too vigorous treatment.

5. **Eye Contamination**
   - Hold eyelids open.
   - Wash the eyes gently with stream of running water immediately. A delay of even a few seconds greatly increases the extent of injury.
   - Continue washing until the physician arrives.
   - Do not use chemicals. They may increase the injury.

Annexure IV

Nutrient composition of important vegetables (per *100g edible protein*)

Crop	Energy (kcal)	Moisture (g)	Macronutrients				Vitamins				Minerals		
			Protein (g)	Fat (g)	CHO (g)	A(iu)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic acid(mg)	Ca (mg)	P (mg)	Fe (mg)
Amaranath	45	85.7	4.0	0.5	6.1	9108	0.03	0,30	1.2	99	397	83	25. 5
Bitter ground	25	92.4	1.6	0.2	4.2	208	0.07	0.09	0.5	88	20	70	1.8
Bottle ground	12	96.1	0.2	0.1	2.5	0	0.03	0.01	0.2	0	20	10	07
Brinjal	24	927	1.4	0.3	4.0	122	0.04	0.11	0.9	12	18	47	0.9
Broad bean	48	85.4	4.5	0.1	7.2	15	0;08		0.8	12	50	64	1.4
Cowpea	48	85.3	3.5	0.2	8.1	930	0.07	0.09	0.9	14	72	59	2.5
Cucumber	13	96.3	0.4'	0.1	2.5	0	0.03	0	0.2	7	10	25	1.5
French bean	32	90.0	1.9	0.2	7.1	600	0.08	0.11	0.5	19	56	44	0.8
Indian Squash	21	19.3	1.4	0.2	3.4	21	0.04	0.08	0.3	18	25	24	0.9
Muskmelon	17	95.2	0.3	0.2	3.5	279	0.11	0.08	0.3	26	32	14	1.4
Okra (Bindi)	35	89.6	1.9	0.2	6.4	86	0.07	0.10	0.6	13	66	56	1.5
Ridge Gourd	17	95.2	0.5	0.1	3.4	54		0.01	0.2	5	18	26	0.5
Pointed Gourd	20	92	2.0	0.3	2.2	652	0.05	0.06	0.5	29	30	40	1.7
Pumpkin	25	92.6	1.4	0.1	4.6	82	0.06	0.04	0.5	2	10	30	0.7
Sponge gourd	18	93.2	1.2	0.2	2.9	396	0.02	0.06	0.4	,0	36	19	1.1
Tomato	22	93.5	1.1	0.2	4.7	900	0.06	0.04	0.7	23	13	27	0.5
Watermelon	26	92.6	0.5	0.2	6.4	590	0.03	0.03	0.2	7	7	10	0.5

Annexure V

Waiting / Safe periods of insecticides

Sl. No.	Insecticides	Crops	Waiting Period (Days)
1.	Malathion 50% EC	Brinjal	1-4
		Toria, Okra, Longmelon, Cabbage	3-4
		Tomato	5
		Onion	6
2.	Quinalphos 25% EC	Cabbage	10
		Cauliflower	1-6
		Mustard	15
3.	Dichlovos (DDVP) 76% EC	Toria	7
4.	Dimethoate (Rogor) 30% EC	Toria, Rough surface Fruits & Vegetable	10
		Smooth surface vegetable and fruits	5-7
5.	Fenitrothion 50% EC	Cowpea, Pea	10
		Cabbage	7
		Pigeon pea	15
		Cauliflower	8
		Mustard	3-5
6.	Metasystox	Mustard	15-18
7.	Methyl parathion 50 EC	Smooth surface vegetable and fruits	4-6
		Rough surface fruits &vegetable	5-8
8.	Phosalone 35 EC	Pea	5
		Cabbage	10
		Green gram	16
9.	Carbaryl 50% WP	Okra	4-5
		Pea, Cauliflower	10-21
		Brinjal, toria, cabbage & tomato	7-21
		Mustard	10
10.	Cypermethrin 10% EC	Okra	4
		cabbage	6
11.	Fenvalerate 20 EC	Okra, cabbage	9
12.	Decamethrin 2.8 EC	Okra	1
		Cabbage	2

Annexure VI

Fertilizer sources for the supply of nitrogen, phosphorus and potassium

(A) Nutrient contents of different fertilizers

Fertilizer	**N(%)**	**P_2O_5 (%)**	**K_2O (%)**	**Other**
Ammonium sulphate	20.5	-		-
Ammonium Chloride	25.0	-		-
Calcium ammonium nitrate	25.0	-		-
Urea	46.0	-		-
Superphosphate (single)	-	16.0		-
Diammonium phosphate	18.0	46.0		-
Urea-ammonium phosphate	28.0	28.0		-
Sulphate of potash	-	-	48.0	-
Muriate of potash	-	-	60.0	-
Manganese Sulphate	-	-	-	30 (Mn)
Zinc Sulphate	-	-	-	21 (Zn)
Ferrous Sulphate 7 H_2O	-	-	-	19 (Fe)
Copper Sulphate S1 H_2O	-	-	-	24 (Cu)
Gypsum	-	-	-	16 (G)

(B) Quantity of the fertilizer to give 1 kg of nutrient

For 1 Kg of N				
Calcium ammonium nitrate		4 kg		
Ammonium Chloride		4 kg		
Ammonium sulphate		5 kg		
Urea		2.2 kg		
For 1 kg of P205				
Superphosphate		6.2 kg		
Diammonium phosphate		2.2 kg		
Urea-ammonium phosphate		3.6 kg		
For 1 kg of K205				
Muriate of potash		1.7 kg		

Annexure VII

Fertilizer sources for the supply of nitrogen, phosphorus and potassium

(B) Nutrient contents of different fertilizers

Fertilizer	**N(%)**	**P_2O_5(%)**	**K_2O(%)**	**Other**
Ammonium Sulphate	20.5	-	-	-
Ammonium Chloride	25.0	-	-	-
Calcium Ammonium Nitrate	25.0	-	-	-
Urea	46.0	-	-	-
Super Phosphate (Single)	-	16.0	-	-
Diammoium phosphate	18.0	46.0	-	-
Urea Ammonium Phosphate	28.0	28.0	-	-
Sulphate of Potash	-	-	48.0	-
Murate of Potash	-	-	60.0	-
Manganese Sulphate	-	-	-	30.0 (Mn)
Zinc Sulphate	"-	-	-	21.0 (Zn)
Ferrous Sulphate 7 H2O	-	-	-	19.0 (Fe)
Copper Sulphate S1H2O	-	-	-	24.0 (Cu)
Gypsum	-	-	-	16.0 (G)

(B) Quantity of the fertilizer to give 1 kg of nutrient

For 1 Kg of N

Calcium ammonium nitrate 4 kg

Ammonium Chloride 4 kg

Ammonium sulphate 5 kg

Urea	2.2 kg
For 1 kg of P_2O_5	
Superphosphate	6.2 kg
Diammonium phosphate	2.2 kg
Urea-ammonium phosphate	3.6 kg
For 1 kg of K_2O_5	
Muriate of potash	1.7 kg

Annexure VIII

List of pesticides restricted or banned in the country

Pesticides restricted for use

Aluminium phosphide	It is to be sold only to government undertakings/ organisations and to be used under strict supervision of government expert or Pest Control measures Operations.
Captafol	Shall be used only as seed dresser. Its use as foliar spray is banned.
Carbaryl	Not to be sprayed at flowering stage of crops.
Dieldrin	Use of Dieldrin shall be restricted for locust Control measures in desert areas
Ethylenedibromide (EDB)	Use of EDB shall be restricted as a fumigant for foodgrains through Central Govt./State Govt. undertakings/ Government organizations.
Methyl bromide	Restriction of its sale and use is similar to that of aluminium phosphide.
Sodium cyanide	Use of sodium cyanide? Shall be restricted for fumigation of cotton bales by Plant Protection Advisor to the Govt. of India.
Lindane	Use of Lindane formulations generating smoke for indoor use is prohibited in India. It can be used for Control measures of insect pests of field crops.
Methyl Parathion	Use is permitted only to those crops where honey bees are not acting as pollina tors.

Annexure IX

Pesticides banned for use in agriculture in India

Name of Pesticide	Name of Pesticides
Dibromochloropropane (DBCP)	Phenyl Mercury Acetate
Endrin	Tetradifen
Pen ta chIoronitro benzene (PCN B)	Calcium cyanide
Pentachlorophenol (PCP)	Copper Acotoarsenite
Toxaphene	Ethyl Mercury chloride
Ethyl Parathion	Menazon
Chlordane	Sodium Methane Arsonate
Heptachlor	BHC (HCH)
Aldrin	Phenyl Mercury Acetate (PMA)
Paraquat-di-Methyl sulphate	Nicotine sulphate
Nitrofen	DDT
Nicotene	Chlorobenzilate

Annexure X

Nutritive constituents, source of vegetables and impact on human health

Constituent	Source	Established or proposed effects on Human - wellness
Vitamin C (ascorbic acid)	Broccoli, cabbage, leafy greens, pepper, potato, tomato	Prevents scurvy, aids wound healing, healthy immune- system, cardiovascular-disease night blindness prevention, chronic
Vitamin A (carotenoids)	Dark-green vegetables (spinach, and turnip greens), orange vegetables (carrots, pumpkin, and sweet potato), tomato	Fatigue, psoriasis, heart disease, stroke, cataracts
Vitamin K	Green onions, crucifers (cabbage, broccoli, brussel sprouts), leafy greens	Synthesis of pro-coagulant factors, osteoporosis heart-disease,
Vitamin E (tocopherols)		
Fiber	Most fresh vegetables, cooked dry beans and peas dark-green leafy vegetables (such as spinach, mustardgreens, butterhead lettuce, broccoli, brussels sprouts, andokra), legumes (cooked dry beans, lentils, chickpeas and green peas), asparagus	LDL-oxidation, immune-system, diabetes, cancer diabetes, heart disease birth defects, cancer, heart disease, nervous system
Folate (folicin or folicacid)		
Iron	All green leafy vegetables	Iron deficiency anemia
Calcium	Okra. tomatoes, peas, beans,	osteoporosis, muscular/
	pumpkin, cauliflower	skeletal, teeth, blood pressure
Magnesium	spinach, lentils, okra, potato, banana	osteoporosis, nervous system,
		teeth, immune system
Potassium	baked potato or sweet potato, cooked dry beans, cookedgreens,	hypertension (blood pressure) strokearterio-sclerosis

Annexure XI

Non-nutritive plant constituents beneficial to human health

Constituent	Compound	Source		Effects on human health
		celeriac, celery, peppers, spinach, parsley, pepper		cancer, allergies, heart disease
Flavones	Luteolin, apigenin			
	quercetin,	onions,	snap beans,	heart disease, cancer
Flavonols	kaempferol,	broccoli, kale,		initiation, capillary
	mvricetin, rutin	peppers, lettuce		protectant
Lycopene		tomato		cancer, heart disease, male infertility
		sweet potatoes, green		
		beans, lima beans,		
		broccoli,	brussel	cancer, heart disease, male
A-carotene		sprouts,	cabbage,	
		kale,		infertility
		lettuce, peas, spinach,		
		squash and carrots		
Beta-		Carrots,	broccoli,	Cancer
carotene		spinach, sweet potato		
	Lutein,	Spinach, okra, summer		
Xanthophyll	zeaxanthin,	squash, turnip		mascular degeneration
	B cryptoxanthin	greens		
	Glucosinolates,	broccoli,	Brussels	
		sprouts, mustard		Cancer, cholesterol, blood
Sulphur	isothiocyanates,			
		greens,	horseradish,	
compounds	indoles, allicin,			pressure, diabetes
	diallylisulphide	garlic, onions,		
		chives, leeks		

Annexure XII

New molecules of insecticides/ biopesticides/ pheromones in vegetable crops

Common name and formulations	Trade name	Recommendations		Target pests
		Per cent	ml/lit or g/lit	
Abamectin 1.8 EC	Vertimec	0.0009	0.5	Mites, thrips
Acetamiprid 20 SP	Pride	0.004	0.2	Sucking insect pests
Beta cyfluthrin 2.5	Bulldock	0.0035	1.5	Fruit and shoot borers
EC				
Fipronil 5 SC	Regent	0.01	2.0	Borers, soil drenching for soil dwelling insects
Imidacloprid 17.8	Confidor, Sensor	0.0045	0.25	Sucking insect pests which are responsible for transmitting viral diseases
SL, 200 SL				
Indoxacarb 14.5 SC	Avaunt	0.0145	1.0	borers
Methomyl 40 SP	Lannate	0.06	1.5	borers
Propargite 57 EC	Omite	0.142	3.0	mites
Spinosad 45 SC	Tracer	0.018	0.4	DBM, lepidopteran borers
Thiomethoxam 25	Actara	0.005	0.2	Seed treatments for sucking pests
WG				
Bacillusthurin giensis (Bacteria)	halt, biolep,dipel, thuricide, *Bt kurstaki, Bt aizawai*	-	0.5 to 1.0	Lepidopteran insect pests
NPV (virus)	*Ha*NPV	-	1.0	*Helicoverpa armigera*
NPV	*Sl*NPV	-	1.0	*Spodoptera litura*
GV (virus)	Granulosis virus	-	1.0	*Plutella xylostella*
Beauveria bassiana (fungus)	Boverin, biotrol	-	3g	Caterpillars, white grubs
Verticilium lecanii (fungus)	Verticel, mycotal	-	3g	Aphids, thrips, whiteflies scale insects
Azadirachtin *Pongamia* (Karanz)	Various neem based products *Pongamia* soap	-	3-5ml	Caterpillars, leafhopper, white flies, aphids caterpillars
Pheromones devices	Heli-lure		12-15	*Tomato fruit borer, Helicoverpa armigera (Polyphagous pests)*
	Spodo-lure		12-15	*Spodoptera litura (Polyphagous pests)*
	Leuci-lure		100	*Leucinodes orbonalis Ibrinjal fruit and shoot borer)*
	Erin lure		12-15	*Earias vitella (okra fruit borer)*
	Nomate-DBM		30	*Plutella xylostella (crucifers dreaded pests)*
	Cue lure or methyl eugenol traps		15-20	*Bactrocera cucurbitae(fruit fly traps)*

Annexure XIII

Waiting / Safe Periods of insecticides on vegetable crops

Insecticides	**Crops**	**Waiting Period (Days)**
Malathion	Brinjal	1-4
50 % EC	Toria, Okra, Longmelon, Cabbage	3-4
	Tomato	5
	Onion	6
Quinalphos	Cabbage	10
25 % EC	Cauliflower	1-6
	Mustard	15
Dichlovos (DDVP)	Toria	7
76 % EC		
Dimethoate (Rogor)	Toria, Rough surface Fruits	10
30 % EC	&Vegetable	5-7
	Smooth surface vegetable and fruits	
Fenitrothion	Cowpea, Pea	10
50 % EC	Cabbage	7
	Pigeon pea	15
	Cauliflower	8
	Mustard	3-5
Metasystox	Mustard	15-18
Methyl parathion	Smooth surface vegetable and fruits	4-6
50 EC	Rough surface fruits &vegetable	5-8
Phosalone	Pea	5
35 EC	Cabbage	10
	Green gram	16
Carbaryl	Okra	4-5
50 % WP	Pea, Cauliflower	10-21
	Brinjal, toria, cabbage & tomato	7-21
	Mustard	10
Cypermethrin	Okra	4
10 % EC	cabbage	6
Fenvalerate	Okra, cabbage	9
20 EC		
Decamethrin	Okra	1
2.8 EC	cabbage	2

Annexure XIV

New molecules of insecticides/ biopesticides/ pheromones

Common name and formulations	Recommendations		Target pests
	Per cent	ml/lit or g/lit	
Abamectin 1.8 EC	0.0009	0.5	Mites, thrips
Acetamiprid 20 SP	0.004	0.2	Sucking insect pests
Beta cyfluthrin 2.5 EC	0.0035	1.5	Fruit and shoot borers
Fipronil 5 SC	0.01	2.0	Borers, soil drenching for soil dwelling insects
Imidacloprid 17.8 SL, 200 SL	0.0045	0.25	Sucking insect pests which are responsible for transmitting viral diseases
Indoxacarb 14.5 SC	0.0145	1.0	borers
Methomyl 40 SP	0.06	1.5	borers
Propargite 57 EC	0.142	3.0	mites
Spinosad 45 SC	0.018	0.4	DBM, lepidopteran borers
Thiomethoxam 25 WG	0.005	0.2	Seed treatments for sucking pests
Bacillus thuringiensis(Bacteria)	-	0.5 to 1.0	Lepidopteran insect pests
NPV (virus)	-	1.0	*Helicoverpa armigera*
NPV	-	1.0	*Spodoptera litura*
GV (virus)	-	1.0	*Plutella xylostella*
Beauveria bassiana (fungus)	-	3g	Caterpillars, white grubs
Verticilium lecanii (fungus)	-	3g	Aphids, thrips, whiteflies, scale insects
Azadirachtin	-	3-5ml	Caterpillars, leafhopper, white flies, aphids
Pongamia (Karanz)			caterpillars
Pheromones devices		12-15	*Tomato fruit borer, Helicoverpa armigera(Polyphagous pests)*
		12-15	*Spodoptera litura (Polyphagous pests)*
		100	*Leucinodes orbonalis Ibrinjal fruit and shoot borer)*
		12-15	*Earias vitella (okra fruit borer)*
		30	*Plutella xylostella (crucifers dreaded pests)*
		15-20	*Bactrocera cucurbitae (fruit fly traps)*

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